THE POTATO IN THE ARAB COUNTRIES

by

INTERNATIONAL POTATO CENTER
LIMA - PERU

and

ARID LANDS AGRICULTURAL DEVELOPMENT PROGRAM

THE FORD FOUNDATION
BEIRUT — LEBANON

Compliments of

International Potato Center

Region IV
Middle East & North Africa

P. O. Box 2379
Beirut, Lebanon

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INTERNATIONAL POTATO CENTER

Apartado 5969, Lima - PERU

Regional address for the
Middle East and North Africa:

c/o ALAD
P. O. Box 2379
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THE POTATO IN THE ARAB COUNTRIES

Proceedings

First Regional Workshop-Seminar on
Potato Seed Production and Storage in
the Arab Countries

Cairo - Egypt
May 10-16, 1974

Edited by:

Primo Accatino PhD	Regional Representative for Middle East and North Africa-Potato Production Specialist The International Potato Center (CIP)
Roger Kortbaoui PhD	Potato Production Specialist Agricultural Research Institute of Lebanon
Shawki Barghouti PhD	Communication and Training Specialist Arid Lands Agricultural Development (ALAD) Program of the Ford Foundation

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Beirut, March 1975

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NOTE FROM THE EDITORS

The papers presented during the Workshop-Seminar were written in one language - either Arabic or English. Much effort went into translating them into both languages. All the papers were edited for style, consistency, and consequently some were condensed while others were revised and restructured. During the translation and editing, efforts were made to maintain the authors' main themes. The authors, however, remain responsible for the information presented in the reports.

Whatever deficiencies are noted are most likely due principally to our decision to make sure the publication date was not more than ten months after the event, which placed a burden on our supporting staff, translators, ourselves and the printer.

Many people assisted in preparing and finalizing this report. Special thanks are due to Dr. Said El Baz and his colleagues for the preliminary translation of selected papers presented at this workshop. Judy Ludlow, Gaby Percival, Fadia Ayoub and Fadia Moufarrege spent long hours in preparing and typing the numerous drafts and the final copy of this report. Their untiring work is highly appreciated.

The reader should note the following information concerning land measurement:

Feddans (Egypt, Sudan)	=	4, 200, 83 m^2
Dunum (in Arab countries except Iraq)	=	1, 000 m^2
Dunum (Iraq)	=	2, 500 m^2

Primo Accatino
Roger Kortbaoui
Shawki Barghouti

PREFACE

The proceedings recorded here are the result of the First Regional Workshop Seminar on Potato Seed Production and Storage in Arab Countries, held in Cairo, Egypt, on May 10-16, 1974. The Workshop-Seminar was sponsored jointly by the International Potato Center (CIP), the Ministry of Agriculture of Egypt and the Arid Lands Agricultural Development (ALAD) Program of the Ford Foundation. Scientists and administrators working on potato production at the Ministries of Agriculture of nine Arab countries (Egypt, Iraq, Jordan, Lebanon, Libya, Saudi Arabia, Sudan, Syria and Tunisia) attended and participated in this event. Invitations were also extended to Algeria and Morocco but unfortunately no representative from these two countries attended the Workshop-Seminar. Together with scientists from CIP and ALAD, participants from FAO (Food and Agriculture Organization of the United Nations) and COMAP (Comite Maghrebin des Agrumes et Primeurs), were also present.

CIP began its Outreach and Training Program for the Middle East and North Africa in February 1974, based in Beirut, Lebanon. It is affiliated with ALAD Program for logistic and program support and its primary objectives in the region are to cooperate with the Arab countries for the improvement of potato production.

The Workshop-Seminar accomplished the following:

1) It provided the opportunity for CIP to identify potato specialists, the organizations that are concerned with potato production and the role they play, the status of potato production in their country, their problems, priorities and efforts.

2) It gave the opportunity for CIP to present its objectives as well as its Research and Outreach Programs which are aimed at increasing potato productivity in the developing countries of the world.

3) It provided the opportunity for potato specialists in the region to discuss potato production and its improvement, to exchange information on common potato problems and the solution and approaches that could be used in solving them. This development of mutual relationship to exchange technical and

scientific knowledge will be of significant benefit in the future.

4) It provided the opportunity to emphasize the fact that the development and improvement of national potato seed production programs, together with proper storage technology and facilities, is of primary importance for increasing potato productivity in the Arab countries.

Primo Accatino
Regional Representative for
Middle East and North Africa
International Potato Center

INTRODUCTION

This Workshop is the first major effort by the International Potato Center (CIP) to associate with National Potato Improvement Programs in the Mid-East and North Africa. As with all of CIP's activities, it was a joint effort amongst the various institutions and country programs in the Region, who have an interest in improving the potato so that it can play a greater role in solving the world food problems.

The success of the Workshop reflects the extent of interest and participation by those who attended. It reflects the enthusiasm for a joint effort by the countries in the Region. It reflects on the excellent hosting by the Government of Egypt, and the facilities they provided. It reflects on the caliber of the scientists who discussed technological advances with potatoes.

We at CIP sincerely hope that this is but the first of a long and rewarding association with institutions and national programs in the Region. In order for CIP to satisfy its global mandate for potato improvement from a home base in Peru, we must depend strongly on excellent regional institutions such as ALAD, the strong national potato improvement programs which may already exist in the Region, and most heavily on the enthusiasm for potato improvement by local national program people.

The excellent reports which I have received concerning this First Regional Workshop-Seminar on Potato Seed Production and Storage in Arab Countries indicate clearly my misfortune in being unable to attend. We at CIP shall do our best to continue to support such cooperative efforts on potato improvement in this part of the world. We welcome visits to our facilities in the birth-place of the potato in South America. We welcome constructive criticism and suggestions at anytime from those of you who are responsible for the development of good national potato improvement programs.

RICHARD L. SAWYER
DIRECTOR GENERAL
INTERNATIONAL POTATO CENTER

CIP AND THE IMPROVEMENT OF THE POTATO

Richard Wurster

The International Potato Center is one of the newest members of the family of international agricultural research centers. We use the abbreviation CIP which stands for the Spanish words, 'Centro Internacional de la Papa'.

On January 20th this year, the International Potato Center (CIP) was three years old, dating from the time an agreement was signed with the Government of Peru officially establishing CIP as an autonomous institution. Since late 1972 CIP has gone through a period of rapid growth in the development of facilities, staffing of positions and in program activities. From an original staff of six with two principal scientists we have grown to a staff of approximately 100, including 45 principal scientists representing 9 countries.

Although CIP started out as a relatively small institution, we have had a number of advantages which have made rapid growth possible. As a single-crop Institute, CIP has been able to concentrate all of its limited research resources on the tuber-bearing Solanum species and on the application of this research for the improvement and utilization of the potato as a world food crop.

CIP is located in Lima, Peru, because Peru and the Andean highlands is the home of the potato. If you come to Peru today, you can still see many of the wild relatives of the potato and many hundreds of cultivated Solanum growing wild in the mountainous regions of the country.

One of CIP's first jobs was to organize a systematic collection of this valuable germplasm which could be used for improvement of the potato beyond that ever before possible. The formation of the International Potato Center in Peru has, therefore, helped to prevent the loss of this most valuable germplasm which is the key for future potato improvement.

The potato, as we know it today, began with virtually a pinch of germplasm which was taken to Europe by the early Spanish explorers. There it remained a botanical curiosity for years before the food value of the crop was discovered and it was hence distributed through Europe. The 'so-called' Irish or European potato was ultimately taken from Europe to the Middle East, Africa and many other regions of the world. Today, however, with the creation of the International Potato Center, the potential exists for the 'lateral movement' and distribution of potato germplasm directly from the Andean Region of South America to the developing countries of the Middle East, Africa and Asia.

In addition to systematic collection, classification, maintenance and distribution of the tuber-bearing Solanum species, CIP has identified a number of other research thrusts to help accelerate the solution of serious potato problems:

1) Utilization of the tuber-bearing Solanum to provide better adapted potatoes for developing countries.

2) Control of selected fungal pathogens.

3) Control of selected bacterial pathogens.

4) Control of selected viruses and insect vectors.

5) Control of selected nematode pests.

6) Development of potatoes with wider adaptation to environmental stress and insect pests.

7) Improvement of general nutritional quality, protein yield and carbohydrate-protein balance; development of economical methods of storage and processing for developing countries.

8) Seed production technology for developing countries; tissue culture techniques for disease elimination and rapid multiplication and distribution of new clones.

9) Application of research results by the CIP Outreach Program to obtain an increase in potato productivity in developing countries. Included within our Outreach Program is also a socio-economic section. CIP is well aware that not all potato problems are those of production. While our scientists are working on potato production problems, it is equally as important to concern ourselves with economic factors which can limit development of the potato as a world food crop.

In determining its research thrusts and planning its strategy in attacking major potato problems, CIP has conducted a number of 'workshops' involving leading potato scientists from all over the world. To date seven workshops and planning conferences have been conducted:

December, 1972	-	Potato Bacterial Wilt Project Planning Conference.
January, 1973	-	Workshop on Germplasm Exploration and Taxonomy of Potatoes.
August, 1973	-	Late Blight Project Planning Conference.

November, 1973	-	Planning Conference on Potato Quality.
February, 1974	-	Nematology Research Planning Conference.
February, 1974	-	Review and Workshop on Cold Resistance.
April, 1974	-	Review and Workshop on Utilization of Genetic Resources.

A further workshop is planned this year on Seed Production Technology.

Through research there exists a tremendous potential for increasing the role of the potato as a world food crop. One thousand million people without sufficient food live in areas of the world where the potato grows well.

Although the potato is often thought of primarily as a starchy crop, in addition to its carbohydrates it is also a good source of high quality protein, minerals and vitamins (except Vitamin A). Because of its relatively short growing season and possible high yields (over 75 t/ha have been obtained in highland tropical regions and two or more crops per year are possible), the potato outranks all major food crops in the production potential for both calories and protein per unit of time. Only three short-season crops: soybeans, beans and peas, outrank the potato in protein production per unit area per unit time. Furthermore, protein quality and amino acid spectrum of the potato compare very favorably with that of other major food crops.

Whilst CIP is not recommending complete substitution of the potato for other major food crops, the nutritional data does demonstrate the value of the potato as both a producer of calories and protein in areas of the world where the potato is adapted. Unfortunately this does not include all regions of the tropics at the present time.

CIP scientists are presently working to solve major problems in tropical countries, such as heat tolerance, day length sensitivity and disease resistance which could greatly extend the range of the potato as a world food crop. At CIP's San Ramon station in the Peruvian 'high jungle' a wide range of potato germplasm is being tested under a hot and humid tropical environment.

Although a valuable tool for the improvement of potato, research itself is not the reason for the existence of the International Potato Center. CIP's purpose expressed in one simple sentence is to help increase potato productivity in developing countries where the need and opportunity are greatest. We believe that CIP's success will be measured not by the number of research papers which are published, but by the increase in potato productivity in developing countries and by the increased utilization of the potato to help solve world food problems. This basic goal will ultimately be realized through CIP's Outreach Program operating in the developing

countries of the Middle East, Africa, Latin America and Asia. CIP's Outreach strategy is based entirely on building strength in National Programs rather than creating CIP programs in developing countries. In order to translate research results into production breakthroughs, the Outreach Program must work with national leaders to create the capacity in developing countries to utilize the technology developed by the Center. The Center is dependent on strong National Programs to implement its strategy. In turn, we hope the National Potato Programs will look to CIP for training and development of their leadership and personnel.

To summarize our objectives, CIP has no intention of having a 'CIP Program' in any country. We are only to work through National Programs to increase potato productivity.

POTATO SEED PRODUCTION

AND

STORAGE TECHNOLOGY

POTATO SEED TECHNOLOGY

Primo Accatino

A great deal of knowledge is being continuously accumulated regarding high quality potato seed in northern temperate countries. These countries are recognized for their highly developed potato production. Physiological factors affecting potato seed as well as potato pathogens are well known. Production schemes with a high degree of sophistication have been designed to overcome problems of production and achieve high potato yield per unit of land.

Physiological Factors which Influence the Quality of Potato Seed

The handling of the potato seed tubers during the growing, harvesting and storing process will affect the productivity of the potato seed by changing the physiological age of the tuber. A potato tuber is a living organism and therefore it physiologically ages. In other words we may expect different behaviour if we consider that the potato seed is capable of ageing.

Changes in sprouting capacity could be used to measure the physiological age of the seed tubers. The sequence associated with ageing has been outlined as:

> One sprout stage, multiple sprouting stage, branching stage and small tuber forming stage.

The stage before one sprout growth is known as dormancy, and the stage of one sprout growth corresponds to apical dominance. In this case we have a young potato seed. The small tuber forming stage corresponds to an old seed. The physiological stage of the potato seed is influenced by the conditions under which the tuber is grown, the length of the storage period, the storage conditions and the previous sprout growth. Seeds age earlier when they have been grown in warmer regions and when the storage temperatures are higher. Seeds of varieties with a short dormancy period have reached their 'old age' stage earlier than varieties with a long dormancy period.

By using physiologically old seeds the foliage growth becomes less abundant. Tuber initiation starts early and the crop matures early. In a short growing period the use of physiologically old seeds may lead to higher yields, whereas in a longer growing season this is often not the case.

Plants grown from too old seeds are often weak and low yielding. Old seed gives weak sprouts. Frequently little potato growth occurs, especially when seeds are planted in cold, wet soil.

When the time between harvest and planting is too short, the seeds are dormants or produce apical sprouts. Methods are available for breaking dormancy or avoiding apical sprouting. When the time between harvest and planting is too long, the seeds may be physiologically too old. The risk of getting too old seeds can be avoided to some extent when good growing and storage methods are available.

Factors which cause Physiological Ageing

1) Effect of Storage: High temperatures in storage encourage sprouting too early in the season. These sprouts should be removed. Potatoes that have been desprouted once usually make satisfactory seed, even though they may be somewhat shrivelled. Repeated desprouting, however, impairs the propagating value of the tubers. Varieties differ in the amount of desprouting they can stand before their tubers are unfit for seed.

   A storage temperature of about 4^{o} or 5^{o}C is considered ideal for keeping potato seed. Seeds stored at low temperatures should be warmed up to about 15^{o}C or higher for about 10 - 15 days before planting. Warming up the potatoes will start sprout growth, and emergence after planting will be quicker. This treatment is specially recommended if the soil temperature is also low (6^{o} - 10^{o}C).

   Relative humidity during storage can also influence the quality of the seed. 85% to 90% of relative humidity is required to keep the potato seed in good shape.

2) Maturity of the Tuber: Generally, fully matured tubers have a shorter dormancy period than tubers harvested at immature stages. This factor of course is dependent on the varietal effects and variations of environmental conditions during the growing season in the different years.

3) Injuries and Bruising of Seed: Potato tubers attacked by pathogens such as Phytophthora, Fusarium, insects, or those damaged mechanically, including cutting, have a shorter dormancy period than healthy and undamaged tubers. Therefore cutting of seed stimulates early sprout growth.

4) Effect of Geographical Source of Seed: Experiences in different potato growing countries show yield differences between seed of the same varieties originated in different locations. This is attributed to the so-called 'place effect'. This place effect is sometimes attributed to differences in seed dormancy which can cause retarded and uneven emergence. Other possible influences, such as tuber-transmitted diseases differing in their virulence from place to place, variable soil and moisture conditions, different fertilizer practices and possible natural selection of somatic mutations, cannot be

ruled out as contributing causes. Further research is needed to study the nature of 'place effect' and to determine its probable causes.

5) Conditions during Plant Growth: The length of the rest period of a certain variety is not constant and varies from year to year. Also the place of cultivation may have an influence on the length of the dormancy period. When potatoes are grown in areas of short day length, they tend to have shorter dormancy period. Also, the length of the dormancy can be influenced by the temperature in which potatoes are grown. High temperature, especially at the end of the growing period, reduces dormancy length. Cool and wet summers increase dormancy length when compared with warm and dry summers.

6) Cutting the Seed: The potato growing countries differ in the use of cut seed or whole seed. Generally, European countries plant whole seed. USA and Canada usually cut the seed. There are some advantages and disadvantages in both practices.

A whole seed of a certain weight has more skin surface than the cut seed piece of the same weight and, consequently, whole seed can produce more stems than cut seed. If at planting time, however, the tubers are still dormant or in apical stage, cutting may lead to an earlier emergence and a development of more stems per seed. In this case the use of cut seeds can give better results. Disadvantages of cutting the seed are related to lower percentage of emergence which is normally due to the effect of seed decay, transmission of several diseases by the knife, such as Virus X and S, ring rot, bacterial wilt, etc. These problems may be partly prevented by knife disinfection.

Due to the number of problems that may be introduced by cutting seed, it should not be used unless great benefit is expected from cutting. When seed is cut just before planting, care should be taken in order that the cut surface does not dry out, not only before but also after planting. Normally with the purpose of saving labor at planting time, seed is often cut in advance and suberization is accomplished by holding the seed for approximately 10 days at a temperature of ± 15°C and a relative humidity of 85%. To suberize the cut seeds, damp sacks can be used to cover them. By taking this measure to promote wound healing on the cut surface, seed decay is prevented. Use of some fungicides and antibiotics could also prevent seed piece decay. The time needed for suberization depends on the variety. Some varieties are more susceptible to Fusarium and are poor in healing. Age of the tuber also affects suberization. Potatoes are more susceptible to Fusarium as age increases. Cutting of seed stored for a longer time is dangerous. Complete and quick wound healing requires high humidity, a temperature higher than

$12^{o}C$ and a sufficiently high oxygen content in the surrounding atmosphere.

Other factors which affect ageing and the quality of the potato seed are the effect of storage temperature on the rate of sprout growth, the effect of desprouting, relative humidity, light, variety, tuber size, etc.

These are the most important factors affecting the potato seed quality. Many problems on the physiological quality of the seed are present in the Arab countries. These need careful and systematic analysis. Northern potato growing countries have developed high technology to prevent potato seed from getting physiologically old and to keep their quality and potential from the summer harvest to the spring planting.

The concern of many Middle East countries is how to obtain high quality seed potato which will express its full potential after planting, when the period between the early season harvest and the following planting is no more than 2 or 3 months. How can seed be aged to avoid dormancy problems after planting? Another consideration is how much of the high seed technology recommended for northern countries should be applied here. Many countries of this region have great potential for developing seed production programs. Adequate climate for seed production exists in higher elevation areas which can also provide adequate environment for storage purposes. Practical techniques for storing potatoes under warmer conditions should be applied such as using light and greening of the tubers.

POTATO VIRUS DISEASES

Lennart Carlstrom

The potato is a crop highly liable to many diseases, virus diseases as well as diseases caused by fungi and bacteria. This property is to some extent dependent upon vegetative propagation. The tubers are formed in the ground in an environment favorable for the development of different pathogenic organisms and with their high water content and all-round composition of nutrients they offer an excellent substrate for fungi and bacterial. The same vegetative character is also responsible for the liability to virus diseases. Once a plant has been infected, the progeny will normally be infected for ever, quite contrary to crops propagated by true seeds, where the viruses in most cases are destroyed in the mature seeds.

We know around 20 viruses which attack the potato. Some of them have a disastrous effect on the single plant, whereas some others have practically no effect at all - slight or no symptoms and no decreasing effect on yields. If all plants in a field are attacked by a severe virus, the yield depression for the whole field will, of course, also be disastrous. On the other hand, if only a few percent of the plants are attacked, we will often find that the depression in yield is practically none. This depends on a compensating effect brought about by the healthy plants surrounding the attacked plants. Those plants will yield more than they could have done if they had to compete with another healthy plant. The denser the planting, the more pronounced the compensating effect.

Detection of Virus Diseases

For the detection of virus diseases we can use ocular inspection, serological testings or biological testings with indicator plants. To this can also be added color reaction methods.

Ocular inspection is complicated by many factors:

- The variability of the viruses. Usually viruses occur in different strains causing different reactions.
- One strain of a virus will often give different symptoms in different varieties.
- The symptom expression is different under different environmental conditions.

High nitrogen dosages can more or less mask the symptoms of many viruses. PVX and PVS can thus be completely masked. PVX causes much more severe reactions in cold than in warm weather, whereas PLRV behaves in an opposite manner. There is also a considerable heat-masking for the combination PVX + PVA. Below 20°C usually the symptom is severe crinkling, but above this temperature the symptoms may become so slight that the infected plants seem almost normal. Symptoms of TRV on the foliage are completely or almost completely masked above 20°C. The same is also true for PSTV. Another complication is that symptoms similar to those of virus diseases may appear owing to environmental conditions. Frequent changes between wet and dry conditions in the field, especially in warm weather, may induce symptoms similar to those of PLRV.

1) Serological Methods

Antiserums can be prepared against most potato viruses. PLRV is an exception. Serological methods are working very well for many viruses such as PVX, PVS, PVM, PVY and also PVA.

The procedure is to mix one droplet of potato sap with one droplet of antiserum. This can be done on a plastic petri dish. Following incubation at 25 - 30°C for half an hour and then half an hour to three hours outside the incubator, the test is finished and the result can be observed by a microscope. The reaction is either a precipitate of virus particles and anti-bodies from the antiserum or an agglutination of chloroplasts depending upon whether the sap is centrifuged or not. If the sap has no virus, the droplet will remain unchanged. To check the reaction there should also be mixed droplets of normal serum and potato sap. When reactions occur in the normal serum, the test is of no value.

2) Biological Methods

A very reliable method for virus detection is to innoculate indicator plants with sap from potato leaves which then react in a specific way. Some plants develop local lesions for some viruses, which appear in 5 - 7 days. Some indicator plants are systemically infected and in this case the symptom appearance is somewhat delayed. Before the plants are innoculated, they are first dusted with an abrasive, usually carborundum powder (400-500 mesh). A piece of plastic sponge is dipped in the sap and then rubbed with a very light hand on the test leaf. In this way, small wounds are made on the leaf surface and the virus particles can penetrate.

The classic indicator plant is *Nicotiana tabacum* which works very well for many viruses such as PVX, PVY, TRV and PVA. PVY^{o} gives vein-clearing, whereas PVY^{n} gives veinal necrosis. The combination PVX + PVY^{o} gives also veinal necrosis. *Nicotiana tabacum* can be used for differentiation

between strains of PVX. Datura stramonium can also be used for this purpose. A very useful indicator plant is the hybrid Solanum demissum A 6 which can be used as detached leaves incubated in a moist chamber. Gomphrena globosa gives clear reactions for PVX. Solanum demissum is a useful plant for the detection of PVY and PVA, but unfortunately two different varieties must be used, one for PVY and one for PVA. Those plants are easy to use, and are highly recommended. All indicator plants need to be grown under special temperature, light and humidity conditions, before and after innoculation. They should be used at a certain stage of development, usually when they are young.

3) Post Harvest Tests

The virus infections can occur at any time during the growing season. If infection is late, it may be impossible to detect when the potato plants are still growing. For those infections we can supply a post control with examination of harvested tubers.

After breaking dormancy with rindite or gibberellic acid, tubers or eye cuttings can be planted and later the plants can be examined according to methods described in the foregoing. For the detection of PLRV it is also possible to examine the tuber itself by a color reaction method.

Following the storage of tubers for about 4 weeks at 16-20°C, slices of the tubers are stained with resorcine blue. If the tubers are infected with PLRV there is an excessive formation of callose in the sieve tubes. This callose retains the dye, which can be observed in a microscope. The method is not 100% reliable but can give a rough idea of the infection with PLRV.

Control of Virus Problems

When we know enough about the mechanism involved in the spread of virus diseases, we have good opportunities to protect the crop. There are several methods we can apply in this connection.

1) Choice of Growing Period

It is of utmost importance to choose the growing period with the objectives of escaping aphids and high temperatures. Regarding virus diseases, it is of course only necessary to escape aphids, but for other reasons high temperatures should also be avoided. Obtaining both objectives will sometimes be difficult in warm countries but, it is quite possible in some parts of the region - for instance some areas in Lebanon.

2) Shortening of the Growing Period

All possible efforts must be made to shorten the growing period and thus shorten the period when plants are exposed to virus vectors. Measures to be taken in this respect are careful seed-bed preparation, application of moderate N-dosages only and use of well presprouted seeds. Presprouting of the seed gives the opportunity of sorting out tubers with thin sprouts before planting. Some of them are most probably infected with PLRV and thus some sources of the virus can be eliminated. Presprouting makes the seed physiologically older and consequently the plants will be older during the growing season than plants coming from non-presprouted seed. When a plant grows older, resistance against virus diseases is usually increased. It is important that development of the crop is rapid and uniform. The faster the development, the more rapidly will symptoms appear on infected plants. When all plants follow approximately the same growth line, the symptoms will also roughly appear at the same time.

3) Early Roguing

It was stated before, that usually the most important spread of virus diseases takes place within a field. To decrease this spread it is thus necessary to rogue the field and dig out diseased plants before the aphid invasion begins. If there are no sources of virus in the field, the invading aphids can do little harm. The only possibility for them to spread virus in that case is if they have been infected before entering the field.

Later roguings will have smaller effects, but the roguing must continue for the whole growing season.

4) Crop Rotation

There are many aims of crop rotation, one of which is to avoid volunteers from potato crops grown earlier in the field. Those plants are very often infected with different virus diseases and thus provide excellent sources of infection. The problem is somewhat difficult. It is quite possible for the potato to live for ever in a field after a potato crop has been grown there. Some plants may be killed by suitable herbicides but still some plants will survive. Another aim of crop rotation is to avoid the building up of infection potentials of soilborne viruses.

5) Weeding

Some viruses can invade different weeds, therefore, it is also important to keep the fields as free as possible from such plants. Regarding for instance

TRV, a common host is Stellaria media.

6) Planting Time for Seed and Ware Potatoes

Preferably seed potatoes and ware potatoes should not be produced in the same region. If this cannot be avoided, the seed crop should be planted before the ware crop, because aphids always prefer young plants to feed on. In that way some infections may be avoided.

7) Aphid Countings and Haulm Destruction

When the aphids begin their summer flights, a critical period begins for the potato. When the population of winged aphids begins to grow considerably, it is necessary to lift the crop or to destruct the haulm within a certain time. This time has to be determined for the region in question.

The need to eliminate the haulm at this time makes it clear that planting must be early enough to allow good development before interruption of growth.

The development of the aphid population must be investigated and followed every year in regions for seed potato production. To carry this out, aphid traps should be placed in different parts of the region and preferably also in neighbouring regions. The traps can be shallow pans filled with water or sticky plates. In both cases the traps should be painted chrome yellow, to attract the aphids.

8) Application of Insecticides

All the abovementioned precautions will not enable growth of high quality seed in this part of the world without using chemicals against aphids. If applied in the correct way, these chemicals are rather effective against PLRV. It is necessary to kill the aphids which invade the fields in the spring from the primary hosts. To achieve this, the fields must be treated with systemic insecticides as early as possible.

Aphids are usually present at emergence time, the chemicals should be applied as soil insecticides at planting time. The plants will then be poisonous for the aphids from the very first emergence until some months later. If aphids are not present at emergence time, the chemicals may be applied by spraying. The first spraying should be carried out when all plants have emerged and then preferably be repeated one or two weeks later. Sprayings started later will usually not be very effective.

The good effect of systemic insecticides against PLRV depends on the special behaviour of that virus. PVY behaves in a completely different way. This virus can be transmitted immediately after the aphid has been feeding on a diseased plant. Thus even if the field is treated the aphid can transmit the virus to several plants before it is killed. For this reason insecticide application usually has little effect against PVY. Early and continued roguing is still the main measure against this type of virus.

9) <u>Machinery</u>

To avoid the spread of mechanically transmitted viruses, machinery and tools used in seed potato growing should not be used in other potato fields. When seed potatoes are cut, the knife should be frequently disinfected by dipping in a strong alkaline solution.

10) <u>Infected Soils</u>

For soil borne viruses the first measure is to avoid soils known to be infected. If this is not possible, the soil can be treated with some nematicide but this is usually expensive.

REQUIREMENTS OF BASIC POTATO SEED PROGRAMS

Richard Ohms

The purpose of a basic seed program is the maintenance or perpetuation of seed stock. These programs may take on several forms depending upon the situation and degree of disease control to be desired. Basic seed program requirements should be made clear in order to evaluate the seed stocks.

For the purpose of this discussion let us approach the basic potato seed programs from the standpoint of location of production, type of planting, indexing procedures and personnel, organizations and agencies necessary to conduct and carry out the projects.

Locations of Production

Traditionally basic seed programs are in temperate zones where there are natural advantages of isolation, sufficiently cold winter temperatures with few overwintering hosts, where the green peach aphid does not overwinter as an adult. Also, in these areas, because of cold temperatures, it is reasoned that volunteer potatoes do not overwinter and serve as reservoirs for virus infection. However, practically all seed areas in the northern climates and mountain valleys have problems with aphids and volunteer ground keeper potatoes. There is nothing nicer than a blanket of snow to preserve ground keepers.

Another often-thought requirement for seed production is high elevation. This can only be answered by asking " Where are the mountains in North Dakota, Nebraska, The Netherlands and many other examples of areas that produce excellent basic seed?" Technology and programs can be used in place of natural advantages. Probably more important are:

- The means by which it is possible to rotate land to control ground keepers,

- The regulation of the type of potato seed planted,

- The aphid control programs where systemic insecticides are used; dormant oil sprays on peach and apricot trees; aphid trapping programs so as to time insecticide application or vine killing, control of nursery stock and transplants coming into the basic seed area and factors that affect aphid build up and migration.

In other words quarantine regulations and disease and insect control programs within the area where seed is to be produced could well affect the success of the

basic seed production more than the northern latitudes, mountain valleys or high elevations.

Type of Planting

In order to control certain soil-borne organisms and volunteers (ground keepers) - potatoes should be grown in a field not more often than once in four years. This may not always be possible, but should be a basic seed production requirement.

Depending upon the degree of control desired, and upon the type of off-season indexing, planting of basic stock can take on various forms or combinations of patterns. These are tuber unit, tuber index, family line and stem cutting.

Tuber unit planting is used in some of the least sophisticated seed stock programs. The meaning of tuber unit is that all the seed pieces of the mother tuber are planted consecutively in the field. Thus, all the plants from the mother tuber are together in the field and, if the unit is diseased or weak, all the progeny can be easily recognized and removed. This type of planting is particularly good for PLRV, PVA, PVY, and other virus that produce visible symptoms. Planting of small whole seed accomplishes some of the advantages of a tuber unit plus lessening the spread of bacteria (black leg, brown rot and ring rot) and virus (spindle tuber and PVX) during the cutting process. The disadvantage to this is that only one plant is observed for symptoms while, with a tuber unit, more than one plant is used for symptoms and disease identification.

Tuber index is a variation of the tuber unit. During the off season a tuber is given a number to correspond to the eye index and, if the eye is good, the remaining tuber is planted. This will be discussed further in the section on index programs.

When the off season index involves testing the production from each hill, all the progeny of the hill are planted in a block and this starts a hill-family line. Within the family block the tuber unit procedure is also followed. The next year's basic stock would come from indexed hills or units within that family. The family line is used extensively when programs are concerned with mild or latent virus such as mild leafroll, PVX, PVS, PVM and mild spindle tuber. If one positive reaction is found the entire family is removed.

Another method which is frequently being incorporated into seed increase programs is the stem cutting procedure. Here a single plant in the off season index is examined for the presence of all known pathogens and, if it has been found free, it then is multiplied prior to field planting by stem cutting. Besides giving the possibility for rapid multiplication the procedure gives excellent control of pathogens adhering to, or in, seed tubers such as verticillium, nematode and the black leg bacteria. Stem cutting also provides a practical step in the refined meristem culture

programs that are concentrating on total pathogen eradication. The stem cuttings are planted in the field in place of tubers, however, in some programs tubers are produced from cuttings in sterile greenhouse soil and these are often planted in the field. Many of us are hopeful that stem cutting procedures will eradicate black leg as a potato production problem. Other diseases may also be controlled by stem cutting such as Verticillium, Pseudomonas, Fusarium and soil invaders such as nematodes.

Indexing Programs

In every seed stock program, there is some procedure for indexing seed stock. Without the important index control procedure to eliminate bad seed stocks or plants before they are field planted, it would be practically impossible to maintain a potato seed stock.

Field index tests have been followed for many years in the United States. A 300 to 600 tuber sample (usually single drop tubers) are collected at harvest from a seed field. The dormancy is broken and the lot is planted in the south during the off season. Diseased plants are then identified and if a lot shows a build up of too much virus the lot is rejected and is not elegible to be planted for seed purposes. Certain virus PVA and PVY have been eradicated from a practical standpoint as factors in a seed program, by the use of the winter (off season) testing.

Of course such index procedures are only as good as the sample and environment under which the test is conducted. Thus accuracy would be restricted by probability and critical disease level. Keep in mind that whenever a sample is drawn, the reliability changes with both the number in the sample and the amount (percentage) of virus.

Selection of single drop tubers for the test will bias the sample toward the detection of seed borne virus of the previous summer. Single drop tubers will give decreased accuracy for detection of current season virus spread the previous summer and this is, after all, most important. In this case the virus will be found more frequently in the large than in the small tubers in a lot, or even between tubers in the same hill. This is particularly true of late season spread of PLRV. If the test is conducted under coastal climate where light intensity is low and temperatures are cool, the detection of PVA and PVY and other mosaics will be favored but the probability of PLRV detection is increased.

These programs concentrating on visible virus have been successful in preventing severely infected stocks from being planted in seed areas and has kept the virus levels under what might be termed manageable control.

Green eye index is used in programs which do not use a southern off season index, but rely on eye index in a greenhouse. Usually a sample of 500 tubers is taken from the seed stock and the bud eye is removed by means of a melon baller. The bud eye is used because leafroll symptoms are much stronger in that eye than in eyes from the stem end. Indicator plant and serology tests can be performed for mild or latent disease during the index.

Recent technological advances have now made it possible to free a potato of most known pathogens (spindle tuber is one exception). This procedure is known as meristem culture. The Russet Burbank variety has been grown in the United States since about 1905. It is now the most important and prominent variety in the United States. Until recent years it was universally infected with black leg bacteria, PVX and PVS. Then the technological advances of heat treatment, axillary bud removal and tissue culture growth finally made possible the production of a pathogen free plant to be increased via stem cutting and family line type programs.

Personnel, Organization and Agencies

No program is any better than the cooperation between various agencies involved in seed production. A basic seed program involves cooperation of the regulatory (inspection and control) agency, the research and educational institutions and the seed producer. Without such cooperation basic seed programs would be sure to fail. Usually these programs need a horticulturist, entomologist, virologist and certification specialist. Certainly no one should attempt basic seed production until these elements of personnel are present and working. Also, a sound multiplication program needs first to be established.

BASIC POTATO SEED PRODUCTION

James Bryan

The objectives of a basic seed program is to maintain small amounts of seed of a given variety or clone indefinitely to provide a good seed source to the potato seed increase scheme. Necessary inputs for the basic seed production scheme include:

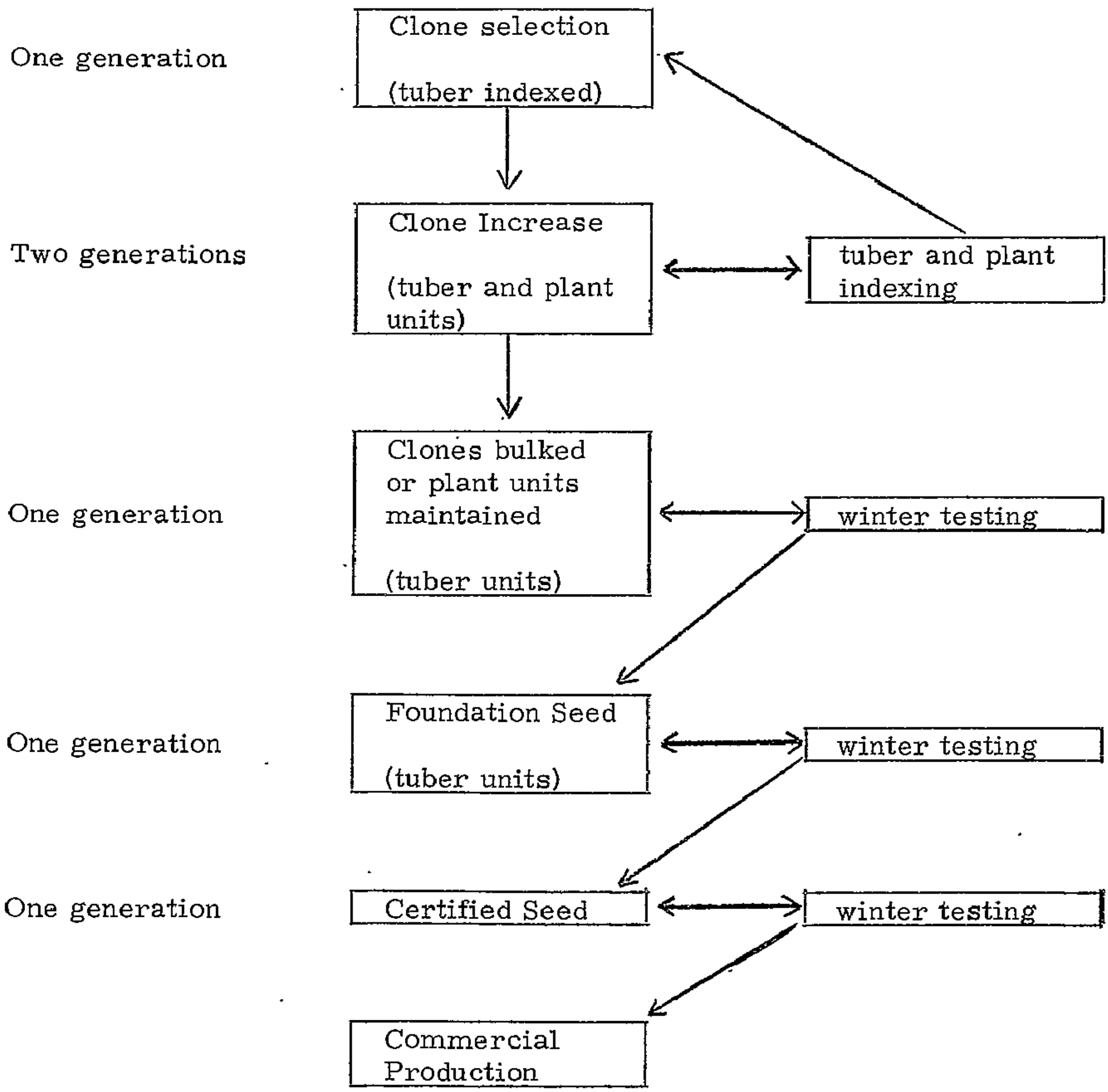
- A government ready to subsidize the program
- Trained scientists with experience in seed increase
- Adequate facilities
- An excellent variety testing program to identify locally adapted varieties
- A grower training program for the multiplication of basic seed
- An adaptive research team, particularly in the pathological and physiological aspects of seed production and storage.

Experience in several countries has taught us that basic seed production is much easier said than done. Peru and Mexico are examples that it can be done. The major problem encountered was governmental reluctance to provide all the necessary inputs.

In Peru, the basic seed program started from a local breeding program because varieties of the specie Solanum andigena were not available from more advanced programs. The Peruvian program was initiated by indexing many tubers from all varieties with high degree of virus infection. Several years were devoted to identifying tubers within varieties that were relatively free of disease. Once done, the long process of increasing a few tubers began. Now, after 7 years, a good supply of basic seed of 4 varieties is available for increase for farmer use. During this 7 years, technical personnel and seed growers have been trained and have gained experience in seed production. In Mexico, the original basic seed came from imported seed. In Mexico, the early work was spent training personnel and seed growers. Clonal selection was accomplished relatively early by use of high quality imported seed. It is hoped that those countries represented here can gain time by utilising the experience of developing countries in such programs. However, a basic seed program is expensive, not just in terms of money, but in terms of trained personnel and time. Money and time invested in potato seed, through direct imports or local increase programs, will probably return more dividends than any other single item in potato production.

Regardless of the scheme you are to use, the important thing is to begin. Many of you will play an important part in deciding if potatoes are to be included in providing a nutritionally balanced diet for your people. You will advise or influence those who will decide if your government is to provide the necessary inputs to establish a meaningful potato program. If that decision is positive, then the seed program will probably be the key to its success.

POTATO SEED PRODUCTION PROGRAM



POTATO SEED MULTIPLICATION IN THE ARAB COUNTRIES

John E. Niederhauser

Importance of Seed Multiplication

If potato is to be more important in the Arab countries, and therefore realize more of its potential contribution to the food supply of this region, we must increase yields and lower the cost of production per kilogram. The first step towards this goal, is to make available more good potato seed at a modest price to the grower at the time when he must plant. This means a reliable seed multiplication program must be established. The only alternative is to import seed on a large scale, and this is not an ideal solution for many countries.

Factors Involved in a Seed Multiplication Program

Certain factors must be understood and employed realistically if a seed multiplication program is to succeed:

1) Location of Seed Growing Areas

It is well known that certain regions are more favorable to the production of high quality seed. The best seed growing regions are usually characterized by lower temperatures (often provided by higher altitudes); by freedom from certain diseases and insects (like bacterial wilt and tuber moth); and by isolation from contaminated areas. Research on the rate of degeneration is necessary to confirm the usefulness of a region to produce good potato seed. While such data are being accumulated, experience of the better farmers is often an excellent guide as to where seed can be produced most successfully. In India it has been demonstrated that seed potatoes can be grown in the season immediately following the hot summer, and harvested early before aphid vectors make their appearance. It is probable that some Arab countries could follow a similar system.

2) Season for Seed Production

To avoid expensive or impractical storage problems, seed production should be timed so that it is harvested 3 or 4 months before the planting of the larger commercial fields where it will be used. This may mean growing seed potatoes in an 'off-season' or in a new area.

The importance of planting vigorous seed that has not been subjected to prolonged storage cannot be over-emphasized. Physiological ageing of the

tubers is perhaps more important than virus diseases in determining the value of seed potatoes. When we hear the comment that 'local seed produced more than imported' the chances are that the local seed was in a better physiological stage for planting, and did better even if its virus content was somewhat greater than that of imported seed.

3) Storage

The importance of suitable storage for seed has already been mentioned, and is so vital that it merits special attention. The length of time that seed must be stored is determined by how long the harvest preceded the planting season. If this period can be shortened, storage problems can be minimized or eliminated. The storage of seed through hot summer months presents a very special obstacle, but recent research in Egypt, Pakistan and India indicates that seed potatoes can be carried through the high temperatures of the summer months by careful management and care. Most of our seed storage technology has been derived from research and experience in the North temperate zone, where cold winters coincide with the storage period. Refrigerated storages simulate this cold environment, but are expensive to construct and maintain.

It is important to devise a new technology for storing seed potatoes in the warmer climates of countries at lower latitudes. In this new technology it has been demonstrated that diffused daylight exposure will largely compensate for higher temperatures. A simple demonstration of this principle is made by placing a few recently harvested tubers on a table in an office. They must be left there for prolonged periods, up to 6-7 months; and become very green but have excellent short, stout sprouts for planting. Further more, green potatoes are less susceptible to pathogens and insects that cause seed-rot after planting. Rather primitive storages that allow daylight to enter may prove to be the long-term solution for potato seed storage in Arab countries. Results of research done in Egypt are very promising. Humidity should be maintained at high levels and this is not too difficult in most instances. The introduction of cooler night air into simple but well-insulated farm buildings is very useful. A serious problem is how to spread large quantities of seed tubers so that adequate light reaches all of them.

Organization of National Potato Seed Multiplication Programs

Successful national seed potato production programs consist of three important components:

1) Seed Growers Association

This is a united group, with certain prerequisites for each member to guarantee compliance with seed growing rules and procedures. Such association

should participate in the formulation of standards for seed production. Often the well organized farmers will supervise themselves, and provide much more complete and beneficial control of seed quality than is possible by controls administered only by government agencies. The properly organized seed production association soon convinces its members that it is to their advantage to be unified and produce uniformly high quality seed.

2) Control Agency

This second component of a national seed potato production program is the official government agency that administers the standards governing seed quality and the performance of farmer producers. This is normally a function of an agency of the Ministry of Agriculture, as it should be. Trained personnel are needed here to properly administer this phase of the program; unfortunately in many such government programs this need is overlooked. The agency should also participate in the formulation of standards to make sure they are realistic and enforceable. The control agency should also administer sampling and indexing of samples from seed fields to guarantee quality.

3) Research

The 'third leg of the stool' for organizing a national seed potato production program is a research project to answer production problems. Data is needed to determine the rate of degeneration in given locations; these must be carefully gathered and interpreted. Mention has already been made of the need for new storage technology for warmer climates; here again the investigator must lead the way. All seed programs must sooner or later learn to cut seed, if the full impact of a harvest is to be felt. The large tubers are excellent for seed, and to avoid planting impractical quantities per hectare, the seed must be cut. Research must indicate the best procedures for obtaining good results from cut seed, which admittedly needs more care and is more exposed to problems than is whole seed. These are only examples of the kind of research needed to backstop good national seed production program.

Finally, research scientists should have the last word on what standards should be for accepting or rejecting a given field. Too often these standards are only copied from seed regulations involved in sophisticated programs. This is not realistic. For instance, is the presence of sclerotia of Rhizoctonia on the surface of the tubers sufficient reason for rejecting a lot of seed potatoes? The basic question here is how important is this source of inoculum to the subsequent crop. Are the sclerotia important or is the main source of inoculum from the soil? Research must supply this answer, and then construct a realistic rule in the standards to enforce a practical control.

National Potato Seed Production Program (See diagram)

The potato seed requirements for each 1,000 ha of commercial potatoes are set out here, using for example two 'rates of multiplication'. A highly efficient rate is 10: 1, while a more common but conservative rate is 5: 1. The figures show that with a multiplication rate of 10: 1, four multiplication stages are needed for one hectare of basic seed to meet the seed requirement for 1,000 ha of commercial potatoes. If the rate is 5: 1, then 5 stages are needed, beginning with a 1.6 ha basic seed field. (For our discussions here, the basic seed program is limited to that stage where the seed source is obtained each year from the same field. Subsequent stages are included in the seed multiplication program even though these stages may be given different names in each country).

Some Guidelines

If the rate of degeneration is low, then it is practical to concentrate the technical manpower available on stage 4 (or stage 5). The subsequent stages will be almost automatic if the basic seed stage is well conducted. However, a complete technical staff is needed to launch a basic seed program. The available facilities, personnel, and economic support must be carefully weighed before embarking on such a program.

If the national program is to rely on imported seed at one stage, this will be determined by the capability of the national program to provide effective supervision in subsequent stages.

First Stage of Seed Production to be included in National Program	National Program Required
Import all seed for all commercial plantings.	Minimal or none.
Stage 1 (one multiplication).	General supervision only in better seed production areas.
Stage 2-3 (two or three multiplications).	A seed inspection service, with one trained inspector for each 100 - 200 ha of seed.
Stage 4 (or 5) (Basic seed production.	A complete staff, including serology surveys, sampling, etc.

Obviously the size of the national seed program commitment will be determined by which stage is selected to initiate the national program. The quality of seed to be imported should be determined by the first stage to.be included in the national program.

If only stage 1 is contemplated (one multiplication) then seed quality 'grade A' is usually enough to meet the need. However, if it is planned to launch a complete program at stage 4 or 5, then 'grade SE' seed should be imported.

In any case the available technical personnel (inspectors, research men, etc.) should be concentrated on the beginning stage of multiplication, and thus maximize their efficiency. For example, if the national seed potato program contemplates importing seed to begin at stage 3, with two subsequent multiplications, then the personnel should concentrate their efforts at this stage 3 (the beginning of the program). An excellent job here will result in a high quality product needing only a minimum of supervision as it is multiplied toward the commercial acreages. One trap into which national programs fall, is to devote too much of the time of few technicians to large acreages receiving only superficial inspections. Better results would be obtained by closer supervision at the earlier stage of multiplication.

For a country to determine at what stage they should initiate the seed multiplication program, a reliable economic study should be made to determine the cost of the program at each stage, and the cost of importation. It should soon be apparent when, and at what stage, importation should begin, if at all.

Though it is difficult to generalize, it is my experience that a virus content of 10% or less will not measurably affect the yield. There are few places which cannot produce seed with 10% virus or less, provided the original seed had 1% or less. Thus one seed multiplication is practical in most places. If one considers that this would multiply the impact of each ton of imported seed by 5-10 times, then the value of this one multiplication can be easily appreciated.

Government, centralized control or ownership of potato seed should be confined to the early stages only. Potato seed multiplications should be in the hands of farmers, organized in a seed growers' association, as early as is practical.

As the national potato seed program develops, it should become at least partially self-supporting, either through direct participation of farmers' groups or through fees collected by the government control agency.

The multiplication of many attractive new varieties is restricted by 'breeders rights' which are respected in most countries. If national seed multiplication programs are contemplated, they may be legally restricted to older varieties, which in most cases are quite satisfactory for national program needs.

A study of national needs, of government commitment and of the environment will reveal what can be done to establish a national potato seed program. This program should be realistic, production-oriented, and begin with what can effectively be done. This is usually a simple 'stage 1', one-year multiplication. The program can move ahead to stages 3, 4 and 5 as personnel become available, and as the economics of the program justify these more advanced steps.

The Role of CIP in the Development of National Seed Potato Production Programs

There is no satisfactory substitute for having a national program staffed and supported by national institutions. CIP can, however, assist in the development of a national potato seed program by:

- Assisting in the identification of goals and organization of the program
- Providing temporary leadership (as national leaders are trained)
- Providing technical assistance as available and needed
- Training personnel, with emphasis on field training, but including graduate academic training for program leaders.

EXAMPLES OF SEED MULTIPLICATION PROGRAMS

Rate of multiplication	10: 1	5: 1
Seed planted	2 ton/ha	3 ton/ha
Seed harvested	20 ton/ha	15 ton/ha

	Production	Seed Required	Production	Seed Planted
Stage 1 (commercial)	1000 ha	2000 ton	1000 ha	3000 ton
Stage 2	100 ha	200 ton	200 ha	600 ton
Stage 3	10 ha	20 ton	40 ha	120 ton
Stage 4	1 ha	Basic Seed Program	8 ha	24 ton
Stage 5			1.6 ha	Basic Seed Program

PRE-HARVEST TECHNOLOGY ON SEED POTATO CROP

D. E. Van der Zaag

This paper covers the following topics:

1) Growth regulators on the production and earliness of seed potatoes

2) Tuber moth

3) Irrigation and soil moisture

4) Vine killing

5) Harvesting

6) Curing

Much help has been received in the preparation of part 1 from Dr. Bodlaender (IBS), of part 2 from Ir. Th. de Bruin and of part 3 from Dr. Rijtema (ICW).

1) Growth Regulators on the Production and Earliness of Seed Potatoes

Introduction

Growth regulators may be used in various parts of the growth cycle of the seed potato crop, such as:

a) Breaking dormancy or diminishing apical dominance

b) Stimulating haulm and stolon growth before tuber initiation

c) Stimulating tuber initiation (increase tuber number)

d) Reducing haulm growth to stimulate distribution of carbohydrates to tubers

e) Inhibition of growth of leaf buds and stem tops to stimulate age resistance

a) Breaking Dormancy or Diminishing Apical Dominance

As this aspect is apparently beyond the scope of this paper, only the chemicals that are used will be mentioned. Both gibberellic acid (Bruisma et al, (1967), Madec and Perennec (1969)) and CS_2 (Meyers (1972)) are on a small scale in practice. GA as a dip for cut seed (concentration varies from 0. 5 - 10 ppm for 10 minutes) and CS_2 as gas (e. g. 10 - 25 cc/m^3 for 3 days at 20^oC). It is clear that concentration and time of treatment must be adapted to the balance between growth stimulators and inhibitors in the tuber. This means that variety and physiological age of the seed tuber should be taken into consideration. Other chemicals that can be used are ethyleenchlorhydrine, ethrel and rindite (a mixture of ethyleenchlorohydrine, dichloroethylene and tetrachlorocarbon). Till now breaking dormancy with chemicals is not done on a large scale in practice. It appears still to be difficult to apply one of the chemicals without risk. In tropical and sub-tropical areas, where several planting times may occur, a reliable and practical method to break dormancy is desirable.

Much easier is the use of chemicals such as GA and CS_2 to diminish apical dominance. This can be done more cheaply by de-sprouting and applying thereafter a heat shock, so that several eyes start to sprout. This method increases the number of stems and thus the number of tubers.

b) Stimulating Haulm and Stolon Growth before Tuber Initiation

To improve production the time between planting and tuber initiation should be short. However, at the time of tuber initiation sufficient weight of haulm should be present. Several experiments have been carried out on seed that has been dipped in a GA solution to stimulate emergence or with GA used as a spray on plants after emergence to stimulate haulm development.

Gibberellin promotes stem elongation and increases total leaf area; the foliage has a lighter color than untreated plants. This increased leaf area has sometimes been accompanied by larger total dry matter production, but this advantage has often been lost and tuber yield adversely affected by such gibberellin treatment. (Bodlaender, 1972).

So far it does not seem practical to use growth regulators before tuber initiation.

c) Tuber Initiation and Tuber Number

GA retards tuber initiation. The content of gibberellins in the stolons decreases at the time of tuber initiation and a high concentration of a - still unknown - inhibitor is present. Abscissic acid is probably not this inhibitor. This inhibitor sometimes promotes tuber initiation, sometimes not. Maleic hydrazide (MH) and triiodic benzoic acid (TIBA) stimulate not only tuber initiation but also malformation of tubers and leaves.

B9 (N. N-dimethylaminosuccinamic acid) and CCC ((2-Chloroethyl) trimethyl-ammoniumchloride) and Ethrel promote tuber initiation or increase the tuber number per plant (table 1, 1) (Humphries and Dyson, 1967, Bodlaender, 1972). Humphries and Dyson (1967) found, however, that B9 stimulates tuber malformation and Umaerus (1974) found for both CCC and B9, if applied before tuber formation, produce a delay in sprout growth of the progeny.

At this moment, no reliable growth regulators can be applied in the seed potato crop to stimulate tuber formation and to increase tuber number.

d) Haulm-tuber Ratio

Several research workers have tried to regulate the distribution of carbohydrates after tuber initiation with growth regulators. B9 has been particularly used and in cases of abundant haulm growth, the application of B9 may result in a higher tuber yield (Fig. 1). In other experiments tuber yield was increased only in early liftings, in late liftings no effect was found, in some cases even a decrease. Renewed haulm growth later in the season which often occurs after B9 treatment may explain these findings. Bodlaender (1972) found that B9 stimulates sprout growth of the progeny, but that CCC retards sprout growth considerably. In Egypt, Radwan et al (1971) found with a late spray of CCC a remarkable increase of yield (table 1, 2).

It may be assumed that in future, growth regulators will be used to regulate the ratio haulm-tuber, if it can be proved that such regulators are not harmful to the consumer or seed potatoes.

e) Inhibition Growth of Leafbuds and Stem Tops

In young potato leaves virus is multiplied more rapidly than in old leaves (age resistance) (Beemster, 1972). To prevent spread of virus in a potato crop it is important that if sufficient foliage has been formed, and aphids are present, formation of new leaves is hampered. Bodlaender

and Algra (1965) tried several chemicals to prevent growth of buds and stem tops with good results. Also virus spread was hampered in these plots. Later on it proved, however that these chemicals also inhibit sprout growth, so that they cannot be used in seed potatoes.

Conclusions

To stimulate production and earliness of seed potatoes at this moment, growth regulators cannot be advised in practice.

Pre-germination is still a good and reliable method of promoting earliness of the crop. Moreover with various methods of pre-germination the grower can regulate more or less the number of sprouts and so the number of tubers.

Further the grower can influence the number of tubers with the number of stems per m^2 (Van der Zaag, 1972). These methods are still the most reliable. Breaking dormancy and retarding haulm growth in periods with high temperatures can be of more importance in tropical and sub-tropical countries than in the temperate zone. It may be desirable to stimulate research on these topics.

2) Tuber Moth

Introduction

Phthorimaea operculella (tuber moth) is an important potato pest in warm climates. The relationship between temperature and various stages of development of the moth is given in table 2.1.

In the Mediterranean area tuber moth can have several generations. In Egypt, even nine generations can occur (Attia and Mattar cited by Rivnay, 1962). The damage is done by the larvae which makes holes in the tuber. The moth deposits the eggs preferably on tubers or in the environment of tubers. If eggs are deposited on potato leaves the larvae will go through the veins and may cause plant wilting.

a) Control of Tuber Moth

Late in the season of the spring crop, when the temperature becomes high, tuber moth becomes active. It is important then that the tubers in the ridge are well covered with soil, so that the moth cannot lay eggs on the tubers. After haulm pulling the ridge often falls open. Careful pulling, with one hand on the ridge, so that the ridge is not pulled open, should always be advised. Though haulm pulling has some advantages, in the case of tuber moth control, chemical or thermal killing of the haulms is preferred. After harvest the tubers should be taken immediately to the

store. In many regions chemicals are needed for an effective control. DDT has been used with much success, both with spraying in the field and dusting of the tubers in the store. Now that DDT is forbidden in most countries, other chemicals should be tested for the purpose. Coordination of this work should be stimulated. Dr. Assem was so kind as to give me the following information: in Egypt, Sevin (a carbamate) applied as a spray in the field and as a dust in the store (1 1/2 kg per 1, 000 kg tubers) gives a good control.

3) Irrigation and Soil Moisture

Introduction

Yield and quality are strongly influenced by the availability of moisture to the crop.

Yield is determined by: length of tuber growth period and tuber growth per day.

Potatoes are sensitive to moisture stress. As soon as this stress becomes too high (depending on the transpiration rate) the stomata are more or less closed, which means limitation of CO_2 diffusion. The concentration of CO_2 in the leaf tissue decreases photosynthesis is reduced. This means a decrease in tuber growth per day and under severe conditions even a break off of the growing season.

Quality can be influenced by shortage of water in several ways:

- Small number of tubers per stem (or plant); in the case of second growth, many little tubers

- Malformation of tubers like growth cracks, etc.

- Glassiness (with almost no starch) in the case of second growth

- New haulm growth in the case of second growth

For seed potatoes especially, the new haulm growth may be dangerous if it occurs in a period when aphids are present, for it reduces age resistance of the haulm.

a) Irrigation before and at Tuber Initiation

For rapid emergence it is essential that the seed tuber is in moist but not wet soil. In rather dry cloddy soil, only moist sprouts will start to grow. In such cases the number of main stems (and also the number of tubers) per plant will be lower than from seed which is planted in fine moist soil.

After emergence the soil moisture content should be kept on a reasonable level, but should not be too high for two reasons:

- To prevent shallow rooting

- To prevent delay in tuber initiation

At tuber initiation the soil around the stolons should be reasonably moist. Too dry and too wet seems to reduce the number of tubers, besides dry soil at that time may stimulate common scab attack.

b) Irrigation after Tuber Initiation

After tuber initiation the potato crop needs much water and the effect of moisture stress on quality and yield can be severe. The amount of water a crop needs depends on:

Crop Reaction - Rytema and Aboukhaled (1973) reviewed the literature on the reaction of various crops to moisture stress. Some of these data are summarized in table 3. 1. It appears that potatoes are very sensitive to moisture stress. It may be assumed that as soon as transpiration is reduced, photosynthesis is also reduced.

Evapotranspiration - Normally only the amount of water transpired by the crop is taken into account estimating the amount of water that must be available. It is, however, evident that the rate of transpiration plays a part. In table 3. 2 this relation is given for a fine textured soil in which 2 mm water/cm soil is available for the crop (available moisture content in the soil is the difference between the content at field capacity (pF 2. 0 = -0. 1 bar or pF 2. 2 = -0. 15 bar) and the permanent wilting point (pF 4. 2 = -16 bar). From this table can be concluded that already at evapotranspiration of 6 mm per day, only 22% of the available moisture content can be used without any moisture stress.

Rytema and Aboukhaled (1973) estimated for the Delta area of Egypt, evapotranspiration rates for a closed potato crop with a height of about 40 cm (table 3. 3). From this table it can be concluded that in the months of April and May the average evapotranspiration of a well closed crop is even above 6 mm per day.

If the soil is 75% covered with green leaves the multiplication factor is 0. 90, 50% covered 0. 70 and 25% covered 0. 45.

Water Holding Capacity of the Soil - Fine textured soils like silty loams, silty clay loams and silty clays may have about 2 mm water per 1 cm soil layer available for the crop (between field capacity and wilting point). Medium textured soils about 1. 5 mm per cm soil coarse textured soils less than 1 mm per cm soil.

Depth of the Effective Root Zone - In a soil with a depth of the effective root zone (in which 80% - 90% of the roots are present) of 50 cm, twice as much water is available for the plant than for a crop with 25 cm depth of the root zone.

The potato root is not strong and has difficulty in penetrating caked soils. Sharp transitions from one soil type to another also severely curtail root growth. For an extensive root system there must be no obstructive layers in the soil profile and the creation of hard layers at depth of between 10-30 cm by cultivation under moist conditions must be avoided. Hard layers of this soil may not only occur as a result of bad ploughing, but also during preparation of the seed bed with wrong implements or under wet conditions. For adequate water supply, a well developed root system is essential.

Depth of Groundwater Level - In most soils the groundwater level is so far below the surface it does not contribute to the water supply of the crop. The water supply to a potato crop in three profiles has been studied by Feddes (1971) (table 3. 4). From table 3. 4 can be learned that only in soils with groundwater level not much below 1 m can groundwater have any importance.

Frequency of Irrigation - To grow potatoes under optimal conditions, i. e. under no-stress conditions, the frequency of irrigation can be calculated from the given data. A crop in full growth on a fine textured soil (2 mm water available per cm soil) and a depth of the root zone of 30 cm has available 60 mm water. According to table 3. 2, 37% of the 60 mm water can be used under no moisture stress (if the evapotranspiration is 3 mm per day). That means 22 mm water. With an evapotranspiration of 3 mm

per day, the irrigation frequency should be once in seven days. Other data have been calculated for other conditions (table 3. 5). For a medium textured soil, the frequency of irrigation should be even higher.

These findings are in agreement with the statement of Dr. Kunkel that in Washington State in periods with temperatures of 35°C or more, and evapotranspiration rates of 8 mm per day or more, irrigation is needed every two days to prevent strong moisture stress in the plants. Yields of 60-80 t/ha are then achievable.

Under ideal temperature and day length conditions for an optimal yield and quality the crop should grow under no water stress conditions. Yields of 80 - 100 t/ha can then be obtained. In countries with an evapotranspiration of more than 5 mm, it may be assumed that often temperature is above optimal. It is evident that in several Mediterranean countries in April and May the daily temperatures are often above optimal (about 25°C). Depending on the variety and nitrogen uptake this may cause a continuing haulm growth. To stimulate the transport of carbohydrates to the tubers instead of using them for haulm growth, a small water stress may be favorable for crop production. Moreover for seed potatoes such a small water stress may hamper abundant haulm growth, by which age resistance can be stimulated. Experiments with various frequencies of irrigation may give more information on this subject.

c) Methods of Irrigation

Furrow irrigation is normally applied in the Mediterranean. It is estimated that with a well operated and maintained system of furrow irrigation, about 50% of the water is actually used by the crop, while with sprinkle irrigation about 75% is used. Roscher (1974) states that for coarse sandy soils a row distance of 75 cm is too wide for furrow irrigation. For all other soils 75 cm or more can be used.

The length of the furrow that can be irrigated in one time depends on:

- Depth of the effective root zone
- Infiltration rate of the soil (soil texture)
- Slope of the furrow

In table 3. 6 various combinations are made. It is very important that the ridges are sufficiently high (at least 20 cm) and that the irrigation water

does not rise higher than about half of the height of the ridge. It is sometimes advised to practice alternative furrow irrigation. It is said that large fluctuation in soil moisture content of the ridge can be avoided.

d) Moisture Content of the Soil at Harvest

At the time of haulm killing the soil of the ridge should not be dry for several reasons:

- A dry soil cracks easily thus making tuber moth infestation easy
- In dry soil stem end discoloration may occur after killing the haulm with chemicals
- For rapid stem setting a somewhat moist soil is favorable

Also at harvest the soil should not be very dry. In a dry soil much more tuber damage occurs than in a reasonably moist soil because:

- Soil attached to the tuber acts as a cushion
- Dry clods may work as stones

4) Vine Killing

Introduction

Haulm killing in seed potatoes can be desirable, to control:

Spread of Viruses - If in the second half of the growing season aphid flights occur, haulm killing can be a good method to control spread of viruses such as leafroll and Y-virus. This method is in general applied in several European countries. It is of course no use if aphid flights do not occur late in summer.

Tuber Infection by Phytophthora - In varieties susceptible in foliage and tuber late blight, haulm killing can be useful to control tuber infection. In areas where tuber infection is no problem or where rainfall is low, there is no need to apply this method.

Tuber Size - In many countries small seed is preferred above large seed tubers. To control tuber size sometimes the haulm is killed before maturity. This is an expensive method for it reduces yield. Much better is to regulate tuber size with stem density.

Tuber Damage - Often a potato crop must be harvested while the foliage is still green. The skin of the tubers of such a crop is not firm and skin and tuber damage can easily occur therefore to minimize tuber damage the haulm is normally killed several days before harvest, so that the skin of the tubers is more firm at harvest.

a) Haulm Pulling

Haulm pulling by hand is the most simple and reliable method. It is, however, labor consuming. In The Netherland a one-row machine has been developed to pull the haulm and now a four-row machine is in development. Such a machine is expensive and the ridges must all have the same shape. It is believed that this machine can only be applied on specific farms. Haulm pulling has the advantage that the skin becomes firm more rapidly than with other systems.

b) Chemical Haulm Killing

In most countries in the temperate zone, haulm is killed with chemicals. Chemicals principally used in Europe are:

- Dinitro-orthocresol (DNOC) dissolved in mineral oil

- Dinoseb (2.4 dinitro - 6 butylphenol)

- Penthachlorophenol (PCP) dissolved in mineral oil

- Diquat

Under dry and hot conditions discoloration of the stem end of the tubers may occur. It is advised to spray under such conditions very early in the morning. Sometimes the haulm is pulverized with a rotobeater before spraying.

c) Thermal Haulm Killing

To avoid chemicals on the fields, machines have been developed to kill the haulm with oil fired burners. These machines have been used in The Netherland in recent years, but with increasing oil prices this method will not be competitive with chemicals. In countries where oil prices are low, this method could be applied.

d) Adaptation of Irrigation to Haulm Killing

Depending on the weather conditions, irrigation should be stopped several days before haulm killing. For haulm pulling by hand the ridge should not be too dry, so that it falls open (tuber moth attack). With chemical haulm killing strong moisture stress in the foliage may stimulate stem end discoloration of the tubers. A well-balanced compromise must be found.

5) Harvesting

Introduction

Damaging tubers at harvesting is the most common phenomenon in the world. Most storage problems can be related to tuber damage. It is therefore essential that tuber damage must be avoided as much as possible at harvesting and transport. Tuber damage is not only a privilege of machines, but it can also occur with rough handwork. Depending on the labor situation in a country, the grower must make a choice of the various systems.

a) Mostly Handwork

The most simple method is to lift the tuber with a fork or spade and pick them by hand. A slightly more mechanized system is to use a lifter or plow that breaks the ridge open and the tubers lying between the soil must be hand-picked. In many countries this method is used. The lifter can be also an elevator-digger that brings all the tubers above ground. The tubers are again picked by hand. Transport of potatoes to store is usually done in bags.

b) Mechanical Harvesting

Increased labor cost has stimulated growers in many industrial countries to use harvesters. Nowadays 1-, 2- and 4-row harvesters are used. Usually they deposit the tubers in an accompanying trailer. At the potato store the trailer is tipped into a kind of hopper where the potatoes often undergo a cleaning process to remove earth and haulm debris. With a conveyor the tubers are transported in the store. Under good conditions 5 persons can harvest with a 2-row harvester in 10 hours approximately 150 tons of potatoes, i.e. 3 tons/man/hour.

In countries with a hot climate it is even more important to harvest the potatoes with almost-no tuber damage. Systems should be developed that are adapted to those countries.

6) Curing

Introduction

Despite careful handling many tubers will be slightly damaged after harvest. A little scuffing and superficial cracks will not cause too much loss if a proper curing period is applied.

A potato tuber is mainly water. The skin should protect the tuber from moisture loss and from attack by bacteria and fungi. A damaged skin opens the gate for the enemies of the potato. To avoid losses during storage, potatoes should be lifted and transported to the store very carefully and in the store, conditions should be made to promote healing of the small wounds so that the skin becomes again a complete cover of the tuber. If much damage can occur during transport, it is preferable to store the potatoes for a short period in the field in a clamp that is covered well with straw. After 1 or 2 weeks the skin is more firm and the wounds are already covered with some cork. This period of healing is called the curing period.

a) Mechanism of Wound Healing

Under favorable conditions, the cells around a wound immediately start suberization. Adjacent to these layers of suberized cells, cork, cambium or phellogen is formed. Both cell wall suberization and periderm formation depend on: temperature, air humidity and oxygen. In figure 2 the relation is given between suberization, wound periderm formation and the temperature. For rapid wound healing the temperature should not be much lower than 15°C. Above 20°C the process is not promoted by temperature, while usually micro-organism activity is stimulated by higher temperatures.

It is known that cork formation needs high humidity. Artschwager (1927) stated that at 70% relative air humidity and at 12°C no periderm was made.

With low humidity, some parts around the wound can form cork, but a strong layer of cork cells is not built. To protect a tuber against moisture loss and attack of micro-organisms correct wound healing is essential.

Metlickij (1968) and his co-workers in USSR have drawn attention to the oxygen supply. They found that a decrease air oxygen content in the surrounding air hampers cork formation, fresh air circulation through a potato heap is advised, even if air humidity is dropped.

It is difficult to say if the findings of Nielsen (personal communication, 1973) that a short period (4 hours) of dry air after lifting stimulates cork formation, can be explained with oxygen supply. To promote wound periderm formation the best conditions are: temperature about 15°C, high air humidity (above 90%), and high oxygen content of the surrounding air. Under such conditions within a week 1-2 layers of well suberized cells can be formed and within 2 weeks 2-4 layers (table 6.1).

It is known that old tubers are slower in formation of wound periderm than young tubers. There are also varietal differences.

b) Wound Healing In Practice

In Western Europe most potatoes are harvested at a temperature between 10 - 20°C and tubers are usually moist without being wet. If such tubers are stored the humidity and temperature will normally not be far from optimum and the air oxygen content may become too low. Sometimes fresh air ventilation at night, when humidity is high, is desirable.

In countries with high temperatures and extremely low humidity at harvest, it is much more difficult to find favorable conditions for curing. If Nielsen (1973) is correct that a short period of dry air immediately after harvest does no harm, that it may even stimulate periderm formation, collecting potatoes in bags and keeping them in the field in dry air for some hours need not be dangerous.

Without well built stores it will be difficult to find under such climatical conditions, favorable conditions for curing. In cold storage temperature may not come below 10°C the first 2 weeks, preferably at about 15°C.

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Table 1.1: The effect of a) spraying with B9 at 5 g/l at time of tuber formation and b) seed size on tuber number per plant. (Humphries and Dyson, 1967)

Seed Size	Control	5 g/l B9
40 - 50	12.8	15.4
70 - 80	14.4	16.2
90 - 100	19.1	21.8

Table 1.2: Yield of potato tubers (var. Alpha) as affected with CCC at different seasons (Radwan, El-Fouly and Garas, 1971)

	Summer Season		Winter Season	
Treatment	Early Spray*	Late Spray**	Early Spray	Late Spray
Control	21.5	21.5	31.8	31.8
500 g/ha	22.1	27.5	39.4	46.3
1000 g/ha	29.3	30.1	36.6	36.7
2000 g/ha	30.6	35.0	35.9	38.7
		kg/10.50 m^2		
LSD/0.05%	5.2		6.3	

Planted 2.3.1967
30.6.1967

* early spray 20 April, 1967
** late spray 5 May, 1967

Table 2.1: The development of the potato tuber moth at various degrees of temperature. After Attia & Mattar and others. (data from Rivnay, 1962).

Temp. in ^{o}C	Incubation period in days	Larval and pupal development in days	Development from egg to adult	Preoviposition period in days
15-16	18			
18	12	80	54	12
20	9			
25-26	5	25-27	27	2-3
27-30	4	18-23	21	3-4
31-35	3	15-17	19-20	3-4

Table 3.1: Moisture stresses in the leaves by which transpiration is reduced (data from Rijtema and Aboukhaled, 1973)

Crop	Moisture stress in bar
Cotton	- 13
Grasses (+ cereals)	- 10
Sunflower	- 7 1/2
Potatoes and pepper	- 3 1/2

Table 3.2: Relationship between the evapotranspiration and percentage of the available water that can be used under no moisture stress conditions in fine textured soil in Egypt. (data from Rytema and Aboukhaled, 1973).

E. Max	%
1	61
2	47
3	37
4	30
5	25
6	22

Table 3.3: Calculated evapotranspiration rate (in mm per day) of a well closed potato crop of 40 cm height in the Delta region of Egypt. (data from Rytema and Aboukhaled, 1973).

	Coastal area	Central area	Giza	Near Desert
January	3.8	2.6	2.5	4.4
February	4.6	4.0	3.6	6.2
March	6.0	5.1	6.0	8.1
April	6.8	7.5	7.5	9.8
May	7.7	9.3	10.2	12.0
October	5.5	4.7	5.9	5.9
November	3.9	2.8	3.3	3.7
December	3.3	2.8	2.5	4.2

Table 3.4: Capillary rise (mm/day) in two soil types at various ground water levels and an average suction of 224 cm (= pH 2.35 or 0.35 bar) at the lower side of the effective root zone (data from Feddes, 1971).

Soil	Depth root zone	Ground water level below surface 0.75 m	1.20 m	1.65 m
		cap. rise in mm/day		
Clay	60 cm	6.5	0.4	0.1
Sandy loam	40 cm	11.0	0.4	0.07

Table 3.5: Amount of water available in the effective root zone under no stress conditions and under 2 transpiration conditions in fine textured soils (data from Rytema and Aboukhaled, 1973).

	E max = 3 mm/day Depth root zone 30 cm	50 cm	6 mm/day Depth root zone 30 cm	50 cm
Available water	22 mm	37 mm	13 mm	22 mm
Frequency of irrigation	7 days	12 days	2 days	4 days

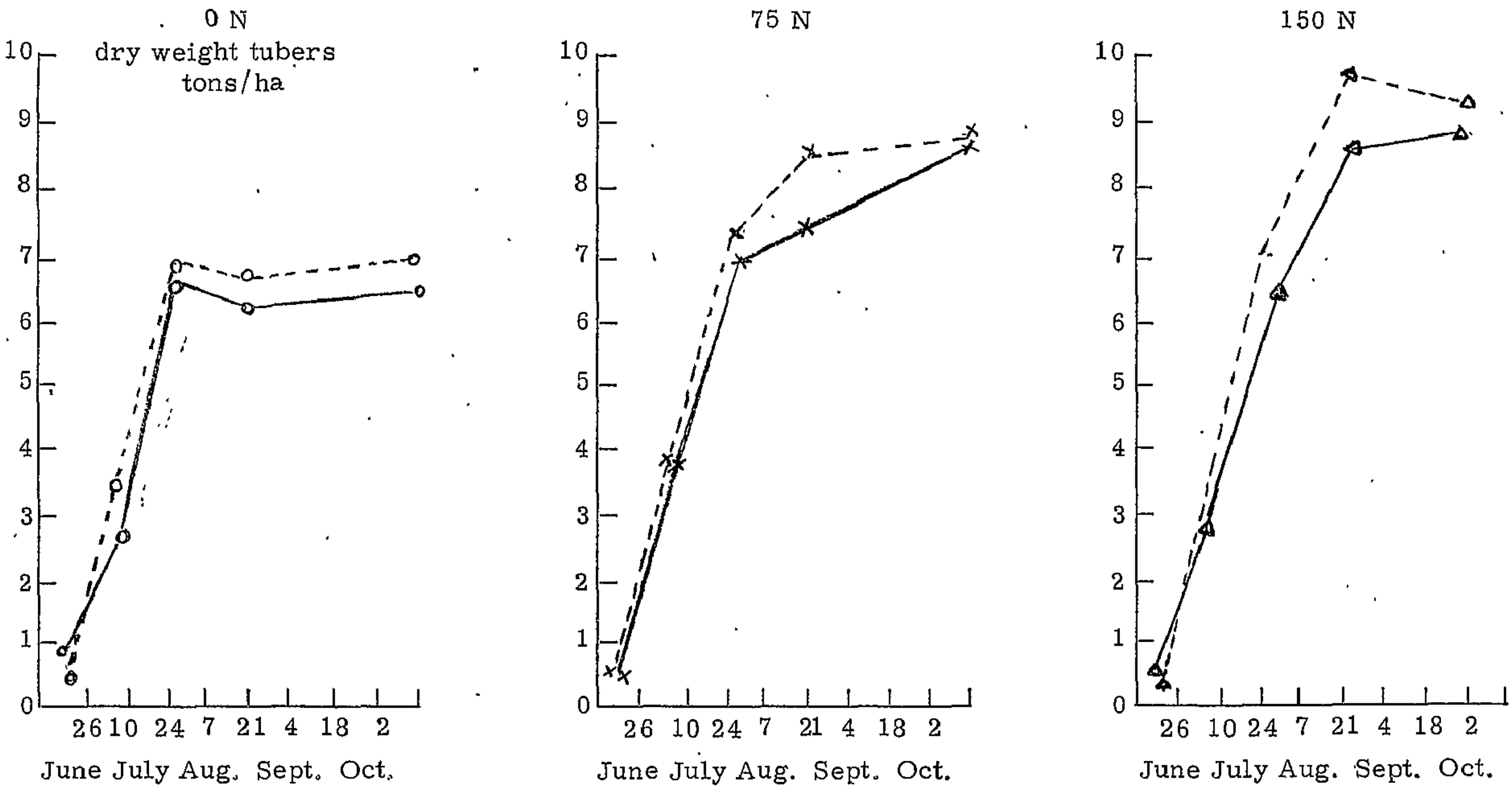
Table 3.6: Suggested length (in m) of irrigated furrows for different soils, slopes and depth of the root zone (data from Roscher, 1974).

Slope	Soil Texture			
	Medium root zone		Fine root zone	
0/00	30 cm	50 cm	30 cm	50 cm
2 1/2	170	225	300	400
7 1/2	105	135	175	250
15	70	100	120	175

Table 6.1: Number of layers of completely suberized cells in wound periderm at 95% R.H. and 15^{o}C (means of about 150 Observations) (data from Paterson and Gray, 1972).

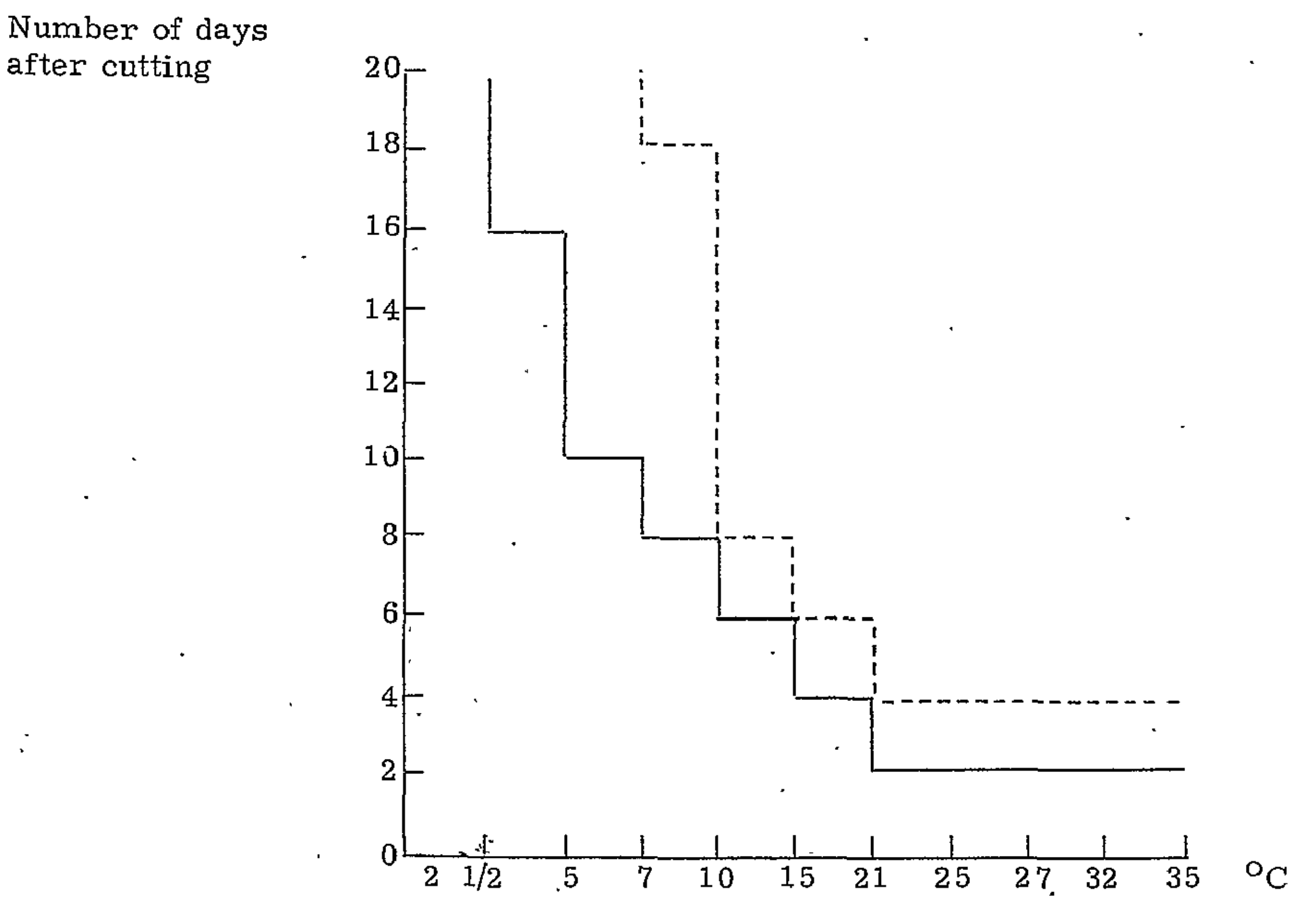
Number of days after cutting	Number of layers of suberized cells
7	1.8
5	3.8
22	4.5
SE of difference	±0.11

Fig. 1: Effect of B 955 on tuber dry weight production of the variety Alpha (data from Bodlaender, IBS, Wageningen)



--- B 955
___ control

Fig. 2: Wound periderm formation and suberization in relation to temperature. (data from Artschwager, 1927).



--- wound periderm present

___ superficial cells suberized

POTATO STORAGE TECHNOLOGY

Said El-Baz

Storage of potato tubers is highly important to both the producer and consumer. It is beneficial for the producer to keep tubers in good condition as long as possible, without economic loss. The consumer needs the tubers to be in good condition with a high nutritive value. Storage is the only means for keeping the marketing quality of the crop and enabling prices to be favorable for both producer and consumer.

Potato storage is extremely important for tubers which will be used as seed for the next season. Productive capacity often depends upon the physiological and pathogenic condition of the tubers before, during and after storage.

It is estimated that 50% of storage problems occur as a consequence of cultural practices applied during the growing process. There are several factors which are considered to be effective for successful storage:

1) Varieties

There is a certain relationship between variety and dormancy period after harvesting. The dormancy period limits to a great extent both storage period and purpose. Varieties with short dormancy cannot be stored for long periods.

Potato varieties are selected according to their productivity and storage capacity. However, some new varieties have poor storage quality. In some regions, early maturing varieties which grow under dry and warm soil for some weeks before harvest are susceptible to decay and sprouting during storage, and also to a reduction in their physiological state. Also thin skinned varieties such as Rosefal, Bintje and others, if damaged during harvest, suffer storage losses due to shrinkage and decay. Care should be taken to avoid such injuries.

2) The Effect of Fertilizers

There is an important relationship betwe n fertilization and keeping quality of potato tubers during storage. For example, excess nitrogen delays maturity, reduces strength of the periderm layer, increases shrinkage and decay during storage and in addition, such tubers are more sensitive to mechanical injuries during harvesting and handling. This agrees with the result of experiments performed in Egypt.

3) Irrigation and Soil Moisture

Soil moisture has a definite effect on tuber quality. Suitable ground moisture helps avoid, to some extent, possible wounds which could occur during harvest. Short irrigation periods at the end of the season in warm climates, decreases soil temperature and consequently tubers are not exposed to sun scald. Low soil moisture during harvest is useful for rapid tuber maturity. On the other hand, dry soil leads to cloud formation and will injure the tubers.

Care should be taken in irrigation, especially before harvest, as excessive irrigation might cause tuber sprouting and affect the quality of the crop in hot climates. This was observed in Egypt and resulted in great losses in the export of the potato crop.

4) Tuber Maturity and Harvest Date

Planting and harvesting periods should be controlled to obtain tubers in a good stage of maturity. Immature tubers must not be harvested to avoid storage loss.

High or low temperature at harvest time causes crop injury according to location and planting date. Potato tubers can be damaged by tuber moth as a result of late harvest in hot climates. This causes great losses to the field crop and during storage.

5) Mechanical Damage

Mechanical damage such as cuts and bruises at harvest and during handling, results in high tuber losses during storage. In addition harvesting during days with much sun, high temperature or high wind, may cause injuries to the tubers such as browning, sun scald, soft rot, etc. Such injuries reduce seed quality and facilitate penetration of bacteria and fungi in the tubers. Consequently tuber loss increases.

Injuries of tubers before storage can be decreased by:

a) Controlling soil moisture.

b). Controlling speed of harvesting tools, and using modern harvesting equipment which reduces the degree of injury.

c) The blade of the harvesting tools should go deeper than the depth of tubers.

d) Harvest should take place during periods of low temperature or early morning. Tubers must not be left free in the field or exposed to high temperatures or winds for long periods after harvest. Tubers exposed to temperatures of more than 27°C or to direct sun rays or strong winds are exposed to the abovementioned injuries.

e) Use of wooden containers with strong walls and rounded corners, or modern containers known as pallet boxes can be used. In addition, containers must be covered to protect the tubers from unfavorable environmental conditions.

f) Tubers should not be thrown from high places during handling and transportation - this causes bruising.

Several factors should be taken into consideration during handling and storage of potato:

1) Tuber Sweetening and the Loss of Ascorbic Acid

These are the most important chemical changes during tuber storage which can affect the value. Tuber sweetening is induced either by low temperature which can be avoided by storing the tubers above 10°C, or as a result of senescence. Sweetening occurs after a few months of storage and it is accelerated by the increase in temperature. Senescence could be controlled by decreasing the temperature to 10°C. This kind of sweetening (increase in sucrose) accompanies the increase of sprouting at the end of the storage period.

2) Losses from Decay Caused by Disease

This could be decreased by storing tubers under high humidity conditions at 10° - 15°C for two weeks after harvest to stimulate periderm formation and then by decreasing the temperature to 2° - 4°C. This is recommended when tubers are wet. However, the required temperature for decreasing decay losses will lead to more sweetening and less quality. Temperature could be increased to 20° - 25°C for 3-4 weeks before processing or consumption and in this case reconditioning of sugars to starch occurs through this process, although this is not suitable for all varieties.

3) Cold and High Temperature Injuries

These injuries occur when storage takes place below -1°C and above 30°-35°C. Storing tubers at 2°C is unsuitable since breakdown occurs in the tissue, especially with some susceptible varieties, without freezing.

4) Weight Losses due to Dehydration

Dehydration could be decreased by periderm formation of the newly harvested tubers. Also weight loss could be controlled by increasing atmospheric relative humidity. Sprout prevention leads to decreased water loss, as sprouts lose water more rapidly than the tubers themselves.

Ventilation is very important in limiting water loss. When ventilation is low, tuber water loss is also low and increases the humidity in the store. Humidity can be increased by artificial ventilation. There is a certain relationship between humidity and air temperature in the stores. If the temperature is low in a limited volume, relative humidity increases. This procedure is applied in Egyptian cold stores. By storing tubers at 4°C, the relative humidity is increased not less than 88 - 90% without humidity control in the cold stores. Regarding water loss from stored tubers, relative humidity is more important than storage temperature. For instance, tubers lose more water if the ventilated air temperature is 2°C with 50% relative humidity as compared with 10°C and 80% relative humidity.

5) Weight Losses by Respiration

Losses by respiration are not as important as other factors during storage. Dry matter losses are 0.12% at 10°C in the first month after harvest which decreases to 0.08% monthly during most of the storage period.

Storage should be at 7 - 10°C for long storage periods and at 4°C if sprouting or spread of decay is impossible to control. Storage at 4°C or 7°C is preferably to be preceded by storage at 10°C or more for 3-4 weeks to stimulate periderm formation since its formation stops at temperatures below 7°C.

A good store must be constructed and directed in a way which allows the best quality either for consumption or seed potatoes during the required storage period.

The location should be considered to permit easy storage and discharge and in the meantime to promote the natural advantages of the region whilst avoiding the disadvantages.

It should be planned on the basis of controled temperature and humidity at all times. Also, temperature should be uniform inside the store and it should have ventilation insulation. Good management leads to successful storage for several months. There are small pits, elaborate cellars, warehouses covered with mud or insulated with waterproof roofs. All these stores have their advantages and disadvantages. The choice is according to the financial funds, supply of construction materials, local conditions and the aim of storage. Generally, there are several

types of stores in potato storage regions, constructed according to the conditions and possibilities of each region.

Use of Sprout Inhibitors for Consumption Potatoes

As mentioned before, storing potato tubers at temperatures that would prevent accumulation of sugars (7 to 10°C) would not maintain the tubers without sprouting. Consequently respiration and evaporation losses would be increased. The problem of sprouting at these temperatures could be solved by the use of sprout inhibitors.

The chemical methods are those most commercially applied. The use of irradiation has also been suggested. However, some objections were based on the facts that irradiation methods can hardly be applied economically in addition to the increased amounts of decayed tubers and rapid tuber senescence.

Most chemical sprout inhibitors are applied by evaporation. They can be used either as a dust in an inert filler as kaolin and the tubers be dusted just before storage, or the chemical can be evaporated through the tubers during storage.

COORDINATION OF ARAB COUNTRIES POTATO SEED PROGRAMS

Mahmoud S. Attia

Potato is one of the most important crops in the world today. It is grown on nearly 25 million ha annually, producing on the average 300 million metric tons. Potato was grown on 130,000 ha and produced 1,387,000 metric tons in the Arab world in 1972.

The average annual area under potato in the Arab countries during the period 1948-52 was 65,000 ha. The projected area for potato 15 years from now, following the same trend would be 266,000 ha. This area will need 572,000 tons of potato seed on the basis of 2 t/ha. It should be noted, however, that the rate of potato seed/ha increases from locally propagated seed.

Potato possesses characteristics that are highly attractive to growers, consumers and government policy makers.

Among these characteristics are:

1) Average production of potato per unit area is greater than that of most grain crops. This makes the potato more attractive to the hungry world.

2) Potato is very rich in carbohydrate content and its protein content could be improved through breeding.

3) Potato is a very good cash crop and with high returns.

4) Potato is one of the most economical crops with regard to water use.

5) Greater chances for better development as a result of introducing and applying modern techniques in seed potato production as well as production in general. The size of the anticipated improvement may be illustrated by comparing the average potato production (7.0 tons/feddan) and the maximum production attained (24.0 tons/feddan) in Egypt.

The potato is not very well known in most of the Arab countries, and its consumption is still low. However, one expects speedy changes in the consumption pattern of people with the development of education, transportation and extension methods of transferring information about the potato.

Potato production expansion in the Arab countries will help the increased demand for food. In most of these countries it is customary to grow potatoes in two main seasons, spring and fall. In some cases, however, some countries grow potatoes for special purposes in a third season. Egypt grows during March and April, new immature and mature potatoes for export.

Generally, the average potato yield per feddan in the fall planting is lower than those in the spring planting by approximately 25% despite better climatic conditions for potato growing in the fall. In addition, the seed rate per feddan for the fall planting is approximately double that for the spring planting due to potato seed piece decay. The main cause for both these defects is the quality of seed used. In the spring planting, seeds are imported from Northern Europe and are of high grades, whereas those used in the fall planting are locally produced and of low grades. The incidence of viral, bacterial and fungal disease is quite high due to favorable conditions for their propagation and dissemination on the one hand and shortage of good training in seed production and inadequate application of measures for their control on the other.

Although improper production of local seeds has caused considerable potato losses, nevertheless it has attracted the attention of both government and growers to the effect of potato seed quality on the outcome of potato production. This was a very important realization. Both governments and growers join hands in their attempts to ensure satisfactory potato seed quality. The following measures have been taken to this effect in most of the Arab countries:

1) Governments insist on importing potato seeds of varieties which proved well, and only purchase highest quality seeds regardless of price. They usually determine the best variety and source of seed in the light of extension experiments 'in situ'.

2) Quarantine laws to ensure the safety of the potato crop in each country have been enacted and implemented. Some countries like Egypt send a quarantine mission each year to examine the potato in the exporting countries before shipping it to Egypt.

3) Governments established potato research units and strengthen them with trained personnel, laboratories, land, etc.

4) Some governments organize the import of potato seeds and delegate authority to special organizations such as the Potato Cooperative in Egypt.

5) Some governments set up terms of storage and handling of potato seeds to minimize any damage which may be inflicted.

6) Most Arab governments have initiated projects endeavoring to improve locally propagated potato seeds.

It is high time that the Arab countries collaborated in the production of potato seed to satisfy their needs. They should not leave the future of such an important crop in the hands of others so long as they possess all the requirements for safeguarding.

To give examples of the dangers which potato production may face, the following are illustrations only:

1) Shortage of potato seed production of required varieties and grades force the Arab countries to buy poor varieties of low grades.

2) The increased demand for potato seed for the Arab countries and failure to proportionally increase the size of potato seed production due to changes in the Northern European agricultural pattern plus shortage of labor result in alarming price rises as happened in 1974.

3) Due to the shortage of available potato seed of high grades and the inadequate implementation of quarantine laws, the chances of introducing new and dangerous diseases and pests are great.

4) In war times such as the second world war, 1956 and 1967 when the Mediterranean and the Suez Canal were blocked, no potato seeds were available and potato production was almost discontinued.

It was as a result of the 1956 war that the first regional potato seed production project was proposed between Egypt and Syria. The project began in 1956.

I am very happy to have heard from Drs. Niederhauser, Wurster and Accatino of the International Potato Center that the Center has no program of its own, and that its objectives are to extend help to any government to implement its own program on a sound basis. I believe such help will be of great value to these countries and will certainly promote potato production.

So far as the financial resources of CIP are concerned, these are limited. Therefore other sources of assistance toward our goal should be welcomed. I discussed with Dr. K.R. Stino, the Director General of the Arab Organization for Agricultural Development, the role which the AOAD can play in the promotion of potato in the Arab member countries and am very happy to report that the Director-General of the AOAD was very enthusiastic in coordinating the AOAD efforts with those of CIP to promote potato production.

I believe that AOAD can be of great help in carrying out the following:

1) Surveying various locations in the member countries in an attempt to locate the most suitable areas for the production of Elite, Registered and Certified potato seed.

2) Surveying potato varieties grown in the member countries; the area grown to each variety and amount of Certified seed potato needed of each.

3) Selecting the most satisfactory area for the production of Elite seed potato to be the site for production where diseases and pests are lowest.

4) Establishing a permanent potato research station in the area designated under 3 and staffing it with the following staff:

1 Director of the Potato Research and Project Manager of the potato seed production project.

1 Breeding expert.

2 Experts in viral diseases.

1 Expert in potato bacterial and fungal diseases.

1 Entomologist.

1 Biochemist.

2 Potato production experts.

1 Administrative officer.

1 Accountant.

1 Storage and handling expert.

The research station, personnel and equipment should be financed by the AOAD directly. The staff should supervise and advise on the production of Registered and Certified seeds in the various locations.

These experiment stations should have the following objectives:

1) Further development of the potato through breeding, introduction, geo-technical methods, disease and pest control, etc.

2) To assume full responsibility for the production of high quality potato seed and high production per unit area.

3) Training of national staff and inspectors in each country on the various aspects of potato seed production and development.

4) Cooperation with CIP and FAO in exchanges of material, knowledge, information, publications, and attending seminars, conferences, training centers, etc., with the objective of enhancing potato promoting efficiency in the Arab countries.

It goes without saying that the AOAD should make available adequate and suitable cold storages and transportation facilities for the project.

THE POTATO IN THE ARAB COUNTRIES

POTATO SEED PRODUCTION AND CERTIFICATION IN EGYPT

Ahmed Sharara

There are two main potato planting seasons in Egypt: spring and fall. The spring planting is either during the end of November and all of December for export, or January until mid-February for the main spring crop. The fall (or Nili) crop is planted throughout the period from August till mid-October. The area devoted to the spring planting is about 30,000 feddans, whereas the fall planting area reached more than 60,000 feddans in 1973. All the seed required for the spring crop is imported from Northern European countries. About 20,000/25,000 tons from different varieties and sources are imported annually, amounting to more than 1.5 million sterling pounds in 1973.

The seed required for the fall planting is taken from the spring crop which was harvested in June, and then stored during the summer months (June till September) in cold stores or uncooled stores. Despite the optimal weather conditions prevailing during the fall season for higher yield, the average yield per feddan is about 30% lower than that of the spring crop. Studies made by the Vegetable Research Department indicate that the deterioration of the fall crop is mainly attributed to physiological and pathological causes. Viral and bacterial infection during the spring season proved to be one of these causes.

On the basis of information, results of comprehensive studies as well as experience gained by the potato staff during training programs in Egypt, USA, The Netherlands, West and East Germany and Ireland, seed potato improvement and certification has been applied since 1965. The following are averages and quantities of certified seed produced throughout the period 1965-1974 inclusive:

Year	Acreage (feddan)	Quantity of Certified Seed (Tons)		
		Delivered by the Potato Cooperative	Stored by the Farmer	Total
1965	800	1,807.0	2,993.0	4,800.0
1966	198	2,367.0	-	2,367.0
1967	473	3,451.5	-	3,451.5
1968	525	2,391.5	758.5	3,150.0
1969	1,050	4,256.0	2,044.0	6,300.0
1970	927	3,689.5	1,872.5	5,562.0
1971	797	4,303.4	478.6	4,782.0
1972	1,864	4,198.5	6,985.5	11,184.0
1973	2,442	7,077.5	7,574.5	14,652.0
1974	2,998	9,234.9	8,753.1	17,988.0

The project has been developed since 1969 in order to produce locally certified seed for the spring planting. This practice has been utilized on the basis of the results of research conducted by the Vegetable Research Department. In these experiments, which were carried out in 1966 - 1968, seed tubers obtained from the spring planting were stored in cold stores from the beginning of June until December, i.e. about 6 to 7 months. The behavior and productivity of these locally produced, cold stored, certified seeds, as well as the health state (from the viral point of view) of plants derived from them, were compared with freshly imported seed of the same variety using all available imported classes. The results confirmed that the productivity of the locally produced seed was as good as imported seed of the same variety. The health state was as good as the certified A class and much better than the imported B class.

According to these results, the following quantities of seed potatoes of different varieties were produced and planted in the spring planting:

1) 300 tons produced in 1969 and used in the spring planting of 1970;

2) 1,000 tons produced in 1970 and planted in 1971.

These quantities increased to 3,000 tons in 1973 which were then planted in the spring of 1974.

The seed multiplication program is now established for importation of smaller quantities of the highest available class and reproduction of these for seeding for the next spring planting. This would permit the accomplishment of the following targets:

1) Producing highly productive certified seed for increasing the fall crop production.

2) Producing seed of varieties traditionally used for export as early potatoes to European markets, from the early spring crop, thus making the exporting season 2.5 months instead of 1.2 - 1.5 months.

3) Satisfying increased demands of seed potatoes for the spring crop.

4) Controlling planting dates and consequently timing and quantity of early production of the spring crop. This would assure stabilization of prices for both the producer and the consumer. This practice would solve the problems of low yields due to late planting which occurs in some years because of late arrival of imported seed.

Another process has been tried for further possible multiplication of seed potatoes locally. For example, 1973 imported seed was planted in the spring of 1973. The certified seed then produced was planted in the spring of 1974. A part of this will be planted in the fall of 1974 and the rest in the spring of 1975 (third generation). Results of these macro plots were very promising and were applied at a limited stage. This program will continue for a fourth generation or more in both spring and fall season in order to study the number of multiplications after which degeneration would occur. Thus the production of potato clones (or basic seed) could be started on a practical and scientific basis in Egypt.

The production and multiplication of virus-free clones requires at least 3 or 5 years, depending on the variety. Egyptian weather conditions permit the possibility of two successful plantings per year. Thus the period of clonal establishment could be curtailed to 2 or 2.5 years instead of 5. However, fall crop yield, usually harvested in December-January, could not be used as seed for the spring crop (planted approximately in the same period), due to the dormancy period of the fall crop tubers. Studies on breaking dormancy of such seed have revealed the possibility of using this fall crop yield as seed in the next spring crop. Tubers harvested in December were soaked in some non-toxic and easily applicable chemicals and planted in January. The yield of this seed was as good as the imported or cold-stored seed.

The best promising treatments were as follows:

1) Soaking freshly harvested fall crop tubers after cutting in 1-5 ppm gibberellic acid solution for 10 minutes. The concentration depends on the variety (degree of dormancy). However, the highest dosage of this range caused elongation of the resulting crop when applied to varieties of short rest period (e.g. King Edward and Sientje).

2) Soaking whole, freshly harvested fall crop tubers in 4-6% thiourea solution for 2 hours then cutting just before planting. The yield of these specific treatments was equal to that of the imported seed or locally produced spring crop seed, cold stored for 6 months. In this was the basic seed program could be safely shortened to two years (four plantings, two each year) instead of 4 or 5 years in the European countries.

<u>Objectives of the Potato Seed Program</u>

1) Increasing the productivity of seed potatoes used for planting the fall crop through control and certification of seed potato fields during the spring crop and adoption of the proper scientific means used for certified seed production.

2) Improving the physiological condition of seed potatoes through improved handling, preparation, packaging and storage operations.

3) Concentrating seed potato fields in the most suitable locations under the control of specialists, and roguing those plants affected with viruses and other diseases which affect seed quality, especially seed and soil-borne diseases.

4) Controlling potato varieties so that the fall acreage will be planted with the most suitable varieties;

5) The gradual increase of locally propagated certified seed potatoes through the limiting of imported seed to the highest available classes of the most suitable varieties under local conditions (according to the program followed for introducing new potato varieties). These high quality seeds are then repropagated to satisfy the requirements of seed for both the spring and fall plantings and to secure export and local consumption needs.

Certification Procedures

1) The location must be isolated from other potato fields or solanaceaes. It must also be distant from places where aphid usually accumulate, such as peach and similar trees. Discussions led to the preference of newly reclaimed areas like North Tahrir and Maryout sectors in addition to the non-traditional potato areas. The traditional potato areas in the Delta are chosen on the basis that all the village fields are planted with one variety and one seed class. Private farms are also utilized. These fields should follow a three-planting rotation. Isolation distances should be not less than 1 km from both northern and western directions (the prevailing direction of wind in the Arab Republic of Egypt) and 200 m from the other directions. The area of each field is from 20 to 100 feddans.

   In addition to the above mentioned aspects for choosing seed fields, villages devoted to seed production should be inspected during the fall planting to ascertain their freedom from soil or tuber-borne diseases. This inspection is done by the Bacteriology Section.

2) Highest available imported seed classes are used for starting material. Foundation seed (Class E) and similar classes are usually used. Additional quantities of imported seed is used from Class A from The Netherlands or similar classes from other countries.

3) Varieties are mainly Alpha, King Edward and to a lesser extent, Grata. Patrones was used in some years.

4) There are correlations between planting date and degree of spread of virus vectors, especially aphids, and infection with tuber moth and tuber rots. All these diseases and insects are less effective when planting occurs during the period from December 25th until January 15th. These dates are sometimes later than the optimal ones due to heavy rains during January or late arrival of imported seed in some years.

5) Small-sized seeds (28-35 and 35-45 mm) are usually planted whole to ensure that virus and bacterial diseases are not transmitted to healthy tubers by knives. However, the majority of imported seeds are larger and these are usually planted cut. The cutting knives are disinfected with 5% sodium or potassium hydroxide, or commercial alcohol. The solution is renewed after cutting 1 to 2 tons of seed. The cut seed is then left for suberization for about 24 hours. The sorted cut seed is then inspected for complete suberization and freedom from rotting diseases. All these operations and practices are done under the close supervision of the potato staff belonging to the Vegetable Research Department, who continuously reside in the seed producing areas and work in cooperation with the staff of the Potato Growers Cooperative.

6) A compulsory spraying program is followed for control of aphid and tuber moth. Aphid control starts immediately after plant emergence, whereas tuber moth control usually begins during the first 2 weeks of March. Both spraying programs are repeated every 10 or 12 days until 10 to 45 days before tuber harvest. Dimenthiote at the rate of 0.1% and Sevin at the rate of 1.5 kg per feddan in 600 liters are used for controlling the two insects respectively.

7) The Virology Section examines samples of imported seed from different varieties and classes for determining the percentage of viral infection. This serves as an indication of probable infection in the field that should be rogued out. After plant emergence, fields containing more than 5% virus secondary infection are not usually used for seed production. Roguing of plants is done by the potato staff in cooperation with the staff of the Potato Growers Cooperative and field workers from the seed producing areas. The fields are rogued 2 or 3 times during growth. The first roguing is done 50 to 60 days after planting, immediately upon symptoms becoming visible.

8) Apart from the staff working on roguing and other operations, other staff from the Vegetable Research Department and the Virus Section make to field inspections and evaluation of seed potato fields. Varietal identify and homogenity of growth are among the factors involved in these evaluations.

Field inspection for virus and other diseases is followed at least once and

usually twice during the growth season, after completion of roguing of diseased plants but before haulm senescence. Potato fields are classified according to the degree of infection, and those devoted to spring or fall seed production are determined.

9) No virus detection is done in tuber samples from the different seed producing fields. About 200 to 500 tubers from each field, according to the acreage, are taken for detecting soil and tuber-borne bacterial diseases. Those infected with any disease considered serious are not used as seed. Seed lots from every field or village are stored in separate partitions inside the cold stores.

10) Seed tuber lots are certified according to the following items:

a) Varieties should be identified and fields inspected during growth.

b) Tubers should be cured for at least 10 days before sorting and grading.

c) Tuber size has to be between 30 and 60 mm in diameter. Hand graded lots could be sized to 28 and 65 mm on condition that those less than 30 or greater than 60 mm are not more than 2% of the quantity.

d) Before storage tubers should be completely free from bacterial diseases such as: black leg, brown rot and soft rot.

e) Tubers should be free from tuber moth. 0.6% traces of infection are permitted on condition that tubers are completely free from any stage of the insect.

f) The combined infection with the following fungal diseases should be not more than 2%:Fusarium rot, scab, Rhizoctonia, early and late blight.

g) The combined infection from the following physiological diseases and defects should be not more than 5%: hollow heart, internal brown spot, feathering, cracking, secondary growth and sun scald.

BASIC SEED PRODUCTION IN EGYPT

Hamid Mazyad

During the past few years trials have been conducted in Egypt to study the possibility of local potato seed production. These trials were planned after the success of the first trial where imported potato seeds were used for two growing seasons instead of one. The Virus Section in cooperation with the Vegetable Research Department have studied the possibility of using imported potato seeds for more than two seasons and in 1971 the Virus Section started the local potato seed program with production of clones. In general, basic seed production depends on three points:

1) Breeding for resistance to virus diseases.

2) Production of virus free plants using heat-treatment or meristem culture.

3) Clonal production and propagation.

Clonal Production in Egypt

This program was started in Egypt in 1971. Individual potato plants were selected from potato seeds imported from The Netherlands in 1970. The variety used was Alpha Class E. The selected plants were tested using serology to determine viruses X, S and M with serum imported from The Netherlands and USSR, and *Solanum demissum* A6, *Gomphrena globosa*, *Physalis floridana* and *Nicotiana tabacum* were used as test plants to determine viruses A, Y and X.

Tubers of selected plants were tested using the tuber indexing method. Healthy tubers were grown and the plants were tested by both serology and test plants three times throughout the season. Tubers of each plant were used as a first year clone. These plants were tested and their tubers in turn became the second year clones. From the third to the fifth year clones, 200 tubers will be tested and the plants will be examined three times during the season. About 10 - 20% of the plants will be tested in the laboratory. The tubers will be used as basic seed for the production of certified seed.

Potato Virus Diseases and their Vectors

According to the data obtained throughout the last 10 years on potato virus diseases and their vectors, the following were observed:

1) The aphid populations in the potato fields in Egypt are lower than those

occurring in potato seed production countries and this may be due to the following:

a) Potato is a secondary host for aphids in Egypt.

b) Many aphid species occurring in Europe have not been found in Egypt.

c) In Europe, aphid multiplied sexually and asexually and the migration of adult aphids from the winter host (Prunus sp) to potato is an important factor for the spread of viruses. In Egypt sexual multiplication of aphids does not occur.

2) Some observations indicated that high temperatures during potato storage controls PLRV in tubers.

3) Preliminary results indicate that basic seed production with high quality is possible under Egyptian conditions.

4) Species of nematode which transmit potato viruses have not been identified in Egypt.

5) The planting period for seed production in Egypt is relatively long (from October to January) compared with other seed producer countries.

INTRODUCTION OF NEW POTATO VARIETIES FOR EGYPT

Mounir Z. Abdel-Hak

The Potato Section of the Vegetable Research Department imports annually new potato varieties and seedlings from different breeding stations and companies in Northern European countries especially The Netherland, France, West and East Germany, Ireland, Denmark, Poland and Bulgaria. These varieties are tested under local conditions in comparison with the commonly grown varieties.

The aim of this testing program is to find out high yielding and quality varieties under local conditions and to search for new markets for seed imports. Exchange of scientific and cultural information between Egypt and the seed producing countries on this vital crop is also one of the aims of this program.

Imported seedlings and varieties are planted in both spring and fall seasons according to the following program:

1) Preliminary Trials

This step is executed in the research stations belonging to the Vegetable Research Department. About 200 tubers from each seedling or variety are imported from the different breeding stations or institutes. Each seedling or variety is planted in two plots with whole and cut seed respectively in order to investigate susceptibility to seed piece decay. The plot size is 17.5 m^2. Data are taken during the growing season about the following:

Percentage and rate of plant emergence

Average number of stems per plant

Vigor of vegetative growth

Type of growth

Preliminary observations on susceptibility to major diseases and pests affecting the potato crop in Egypt

Degree and time of maturity.

At harvest time total yield per plot, average number of tubers per plant, size and observations on tuber characteristics are recorded.

This stage is undertaken for 2 to 3 years for each seedling. The promising ones are then introduced for further testing in the major potato producing governorates (interprovincial trials). Those which are not suitable under local conditions are discarded.

2) Interprovincial Trials (micro plots)

This stage is undertaken in contract with skilled growers in the main potato producing areas i. e. Behira, Gharbia, Menoufia, Giza and Menia governorates. About 500 to 1000 kg of the promising seedlings or varieties from the preliminary trials are imported annually. About 20 to 30 varieties are planted in a complete randomized block design with four replications in each location. All experiments in this stage are planted with cut seed, after being suberized for 24 to 48 hours. The plot size is 17.5 m^2.

Data on growth and yield are taken as previously mentioned in the first stage. Grower's impressions of the varieties plus local marketing ability are also considered. This stage continues for about 2 to 3 years for each variety after which the promising ones are introduced into the final stage, i. e. macro plots.

3) Macro Plot Stage

This stage is done also in contract with some skilled growers in the main potato producing governorates. Two or three, promising varieties are planted in each farm. The area per variety is about one or two feddans.

This stage continues for two years after which the promising variety or varieties are recommended for inclusion in the official list of potato varieties that can be imported for potato production in Egypt.

The following are the names of the seedlings that proved to be successful under local conditions:

Seedling	Name
Ropta J 1857	Jaerla
Ropta M 1383	Marijcke
Englum H 468	Humalda
ZPC M 52	Bonte Desiree
ZPC 58-36	Pocomas
ZPC 59-14	Blanka
BE 58-6-39	Baraka

The following are new varieties included in the Egyptian official list of varieties in addition to the old traditional ones:

Dutch varieties:	Patrones Desiree Jaerla Baraka Bonte Desiree Mirka
W. German varieties:	Grata Cosima
French varieties:	Claudia
Danish varieties:	Kenva

Finally, there is no doubt that the program and procedure followed in Egypt for testing and introducing new high yielding varieties of good quality is a valid means for improving potato production in Egypt. However, we hope that in the near future we could test and introduce some seedlings or varieties bred in countries with similar climatic conditions to those in Egypt and the Arab countries, such as Latin American countries. In this way, highly productive varieties, resistant to prevailing diseases and of desired horticultural characteristics could be introduced in the Arab countries.

POTATO BACTERIAL WILT IN EGYPT

Kamel Y. Michail

The first report on the occurrence of the bacterial wilt or brown rot disease of potato in Egypt was made in 1925 by Briton-Jone, based on symptomatology only. The disease, however, did not appear in potato fields until the late fifties, since when it has progressively increased. The causative bacteria was isolated by Sabet in 1961. The first report on the distribution of the disease in Egypt was prepared in 1970.

Bacterial wilt represents one of the most serious problems for the potato crop, which is one of the major export crops in Egypt. In addition to yield reduction due to wilting and decrease in tuberization, death of infected plants may also occur.

Dissemination of the disease takes place mainly by infected tubers. In addition, the soil represents an important source of infection. Therefore, a study was conducted to evaluate the economic importance of the disease, and to determine the percentage of infection during the years 1967 to 1972 in different locations.

The study revealed the following:

1) The disease is restricted to certain areas and is not prevalent in all inspected potato fields. The percentage of infection varies from governorate to governorate, and the most serious damage was found in Kalyubia, Dakahlia, and Giza governorates.

2) The percentage of infection has been progressively increasing in infected locations. In Kalyubia governorate for example, 3.7% of the total cultivated area during 1967-68 showed more than 5% infection, while in the year 1971-72, the area showing 5% infection reached 67.7% of the potato cultivated area. The highest percentage of infection all over the inspected governorates was less than 25% in 1967-68, whereas in 1971-72 infection reached 50% in certain fields. This may be due to intensive potato cultivation, inadequate use of crop rotation, and extra division of seed tubers. Also, the farmers of these areas were accustomed to use seed from the summer crop in the fall crop (Nili season).

3) The disease is more serious in the fall crop than in the summer one. Generally it could be stated that the main percentage of infection in the fall crop may be three times that of the summer crop and this may be due to:

   a) The probable source of infection in the fall crop is both infected seed

tubers and soil. In summer, soil would be the main source of infection because imported disease-free tubers are usually used at that time.

b) The adequate predisposing environmental conditions in the fall season which start at the beginning of September when soil temperature is favorable for pathogen proliferation. Therefore, typical wilt symptoms appear after the first or second irrigation. Unfavorable soil temperature in the summer planting delays infection until the middle age of the plants when they become woody and thus withstand infection, showing only a typical wilt symptoms.

4) Infected seed tubers are the most important source of infection, and since it is difficult to eliminate the pathogen from infested soil, the following precautions have been taken, compulsory by law, from the beginning of 1971-72 season:

a) Exclusion of infested areas from seed production under the supervision of the Ministry of Agriculture.

b) Crop produced in infested areas must be locally consumed and is not to be used as seed tubers or for export.

c) Farmers in infested areas have been advised to use disease-free seeds, suitable crop rotation, and whole tubers for cultivation.

Inspection of these areas, starting with 1972-73 season, revealed that both percentage of infection and severity of disease were greatly reduced.

POTATO STORAGE IN EGYPT

Ahmed Sharara

Sorting and Grading

After completion of the curing period in the seed potato fields, tubers are sorted for elimination of those not suitable as seed. This includes tubers less than 30 mm or greater than 60-65 mm as well as tubers showing disease or insect attacks, secondary growth, cracking etc. This preliminary sorting is done by hand in the field. Seed tubers are then transferred to the packing centers either in jute bags or reed crates. These packing centers are in the neighbourhood of the cold store houses of the Potato Growers Cooperative. Tubers are resorted and graded either mechanically or by hand under the supervision of the potato staff of the Vegetable Research Department.

Packing, Certification and Storage of Seed Lots

Sorted and graded lots are packed either in reed crates, 30 kg each or in jute bags, 25 kg each. The majority of seed lots are packed in the reed crates. A certification tag signed and stamped by the potato staff is then put in each crate. Names of location, grower, variety and class of seed are declared on the tag. The seed packages are then stored in the cold store houses at 4-5°C and about 90% relative humidity for 3.5 - 4 months. This period can be extended to 6 or 7 months in the case of seed used for the early spring production for export. Seed lots are inspected periodically inside the cold store houses to assure proper storage and temperature management. Samples are taken prior to storage for tuber disease inspection.

Temperature is gradually increased to 10°C shortly before the end of the storage period. Seed packages are left outside the cold store for 7 to 10 days, then resorted and packed in new jute bags under the supervision of the potato staff of the Vegetable Research Department. The bags are then sealed and ready for delivery.

Of the 30,000 tons of potatoes regularly stored in cold stores in Egypt, 16,000 tons are owned by the Potato Growers Cooperative, and the rest by state and private sectors. The total quantity of cold stored seed represents only 30% of the requirements of seed potatoes for the fall planting. The rest are stored in normal traditional non-cooled storehouses called "nawallat".

Seed Potato Storage in Nawallat

Nawallat are simply built of mud or normal bricks. There are small openings all over the walls except for the southern wall for ventilation. The ceiling is covered with mats and rice straw. Potatoes are heaped inside this building up to a height of 1 m and width of 1.5 - 2 m along the whole length of the store. Tubers are thoroughly dusted with DDT (10%) or Sevin (10%) then the heap is covered with a 30-50 cm straw layer. The heaps are sorted every two weeks for discarding of decayed tubers. Tubers are taken out of the nawallat for planting the fall crop during late August and September. The length of the storage period depends on location, variety and planting purpose.

Drawback of the Nawallat Storage

1) The increase in weight loss and decay which usually reaches 20-25% is mostly due to evaporation and respiration, since the temperature inside the potato heap ranges from 22 - 26°C. When the outside air temperature is 28-38°C, the amount of loss reaches 40% when tubers have been infected with tuber moth before or after harvest.

2) Short dormancy period and early sprouting of tubers due to high holding temperature inside the heaps (22 - 26°C). The temperature sometimes reaches 28°C which causes sprout death and black heart.

3) Decreased productivity of seed tubers due to early senescence brought about by early and excessive sprouting.

4) Some growers store their potatoes in heaps up to 2 m high, which leads to increases in the aforementioned losses.

A trial was conducted for improving the storage system and technique in the non-cooled store houses by blowing cold outside night air through an automatically controlled fan. Results showed that this system is not yet sufficient under local conditions, since the minimum night air temperature during the storage season did not fall below 22°C. However, weight loss and decay was relatively less than that of normal nawallat and tubers were more sound with less shrinkage.

Research on the use of different controlled temperature showed that the productivity of seed tubers stored at 10°C for about three months was similar to those stored at 4°C for the same period. This result would encourage the use of insulated store houses with a simple air cooler and humidifier so that the temperature is maintained at 10± 1°C. This practice could be a good and reasonable substitute to the expensive refrigerated cooled stores.

Growth Regulators

Research conducted on the use of some growth regulators to inhibit sprouting of consumption potatoes or to retard sprouting of seed potatoes confirmed the possibility of using IPC and Cloro IPC mixtures to keep consumption potatoes firm and without sprouting for 5 months under non-cooled storage.

Spraying the potato haulm with CCC, 25 days before harvesting the spring crop led to decreased weight loss and sprouting under nawallat storage, and increased tuber productivity of the fall crop.

POTATO EXPORTATION IN EGYPT

Mahmoud Adl-El-Din

Potato is considered the fifth most important agricultural export crop in Egypt.

The amount exported in the last four seasons is indicated in the following table (in tons):

Summer Season	Public Sector: King Edward	Public Sector: Other Varieties	Private Sector	Total
1969/70	22,908	3,095	12,000	38,003
1970/71	35,950	-	4,942	40,892
1971/72	32,038	9,498	17,000	58,536
1972/73	45,000	600	23,500	69,100

Most of the export of this crop is the King Edward variety produced in the main crop (summer season) and exported as immature potatoes (new potatoes) to the English market.

The potato seed for the summer season is imported annually, but the seed for the winter season is reserved from the summer crop.

Potato exports could be increased by applying the following practices:

1) Plant as early as the last week of November with suitable intervals between planting times to that harvesting can begin in the last week of February.

2) Concentrate the crop in large areas to make easier its supervision, spraying, handling and transportation.

3) Spraying against late and early blight and potato tuber moth should be done at the right time. Harvesting should occur at the correct stage of development.

Winter exports is fluctuate as indicated in the following table (in tons):

Winter Season	Public Sector	Private Sector	Total
1969/70	34,640	16,350	50,990
1970/71	13,479	20,582	34,061
1971/72	16,231	400	16,631
1972/73	22,833	13,000	35,833

PROJECT FOR POTATO DEVELOPMENT IN IRAQ

Summary of the presentation by Ahmed Hassan

This project is under the supervision of the General Organization for Agricultural Development and the General Company for Agricultural Production. The latter is also responsible for the execution of the project which is being carried out by means of contracts with the cooperatives.

The potato is an important economic crop in Iraq, and accordingly necessary measures should be taken for its increase, particularly considering that Iraq has good soils and adequate climatic conditions for increased productivity. This crop can be planted twice a year, therefore growers are economically motivated to cultivate it.

Potato production in Iraq is low, but there is an increasing demand for the crop due to high prices of other crops and population growth. A plan is now under way to increase production to 100, 000 tons of potatoes for consumption yearly.

Importance of the Project

The target of this project is to produce 100, 000 tons of ware potatoes every year. Two factors should be taken into consideration: potato seed and cold stores. Cold stores have already been built and good management provided, but potato seed, considered to be the essential factor for the success of this project, needs further development. To ensure sufficient seed, a small amount should be imported yearly for local multiplication and distribution to farmers.

The importance of this project is that the production of local seed will save about 1 million dinars in foreign currency which is presently paid for importing 20, 000 tons of seed yearly. Problems of importing seeds are:

1) The large quantities required.

2) Fixed times for arrival of the seed.

3) Possibility of not acquiring the varieties needed.

4) High cost.

5) Possible entry of new potato diseases.

The project requires the importation of about 2,000 - 3,000 tons of seed only, which may decrease to 500 tons with the improvement of local seed production.

Potato Production in Iraq

Conditions of potato production throughout the world and in the Arab world, indicate that production policy, particularly with regard to nutritive crops, is becoming more difficult by the years.

Commercial potato growing in Iraq has begun only recently and is increasing rapidly. During the next few years, production may be high enough to meet the country's needs, provided sufficient seed and cold-stores are made available.

The following table shows potato production development in Iraq during the last few years.

Year	Spring Season		Autumn Season		Total Year	
	Area Dunum	Production Ton	Area Dunum	Production Ton	Area Dunum	Production Ton
1970	600	1,500	2,500	2,000	3,100	3,500
1971	1,000	2,500	1,000	2,000	2,000	4,500
1972	2,500	6,000	3,000	5,000	5,000	10,000
1973	5,000	12,500	8,000	12,000	13,000	24,500
1974	7,000	program to be repeated				

The success of the previous project which was undertaken through the years 1971-1974, together with the desire of farmers to plant potatoes, has encouraged the preparation of a new project aimed at increasing production to 100,000 tons annually.

To avoid problems of seed importation, local seed should be multiplied, and this could be done as follows:

1) 500 tons of foundation seed to be imported in order to produce 2,500 tons of certified class A seed, which could be stored in cold-stores for next year.

2) Planting of 2,500 tons of certified class A seed to produce 12,500 tons of certified class B seed to be stored for the next year and distributed to growers all over the country.

Project Needs

There is an insufficient number of technical experts in Iraq, and those already there are charged with other responsibilities. Specialized university professors may be asked to give their assistance during field inspection periods. Also, foreign experts may be invited for limited periods. Furthermore, technical training should take place in the country and abroad.

The country lacks scientific research concerning seed production, planting distance studies, potato diseases and protection methods.

Due to the severe climatic conditions of Iraq, more mechanization is needed. The suitable climatic periods for agricultural processes are so short. Planting and harvesting should take place in a short time, making mechanization most advisable. If the potato crop is to increase on a large scale, necessary machines should be at hand.

Storage should be under low temperature and harvesting of spring crop takes place in summer when temperatures are very high and a large proportion of the crop is exposed to damage.

Planting techniques, methods of irrigation, fertilization, protection against diseases should be introduced on scientific bases.

POTATO PRODUCTION IN JORDAN

Nabil A. El Tagi and Rafei Abderrahim

There are about 355,000 dunums in Jordan which are irrigated regularly in the Aghwar Region. This land is below sea level and has warm winters.

After completion of the King Talal Dam during the next three years, the cultivated area will be increased by 120,000 dunums. There are also about 100,000 dunums of cultivated land above sea level.

In order to raise the social and technical standards of the farmers, a law for the Farmers Union will be issued to regulate them in cooperative societies in the Aghwar Region.

In this Region, there are small areas of about 2,100 dunums used for growing potatoes, which produce about 3,000 tons.

The annual consumption of potatoes in Jordan is about 25,000 tons. Most of this amount is imported from Lebanon. Due to the unstable prices of tomatoes in the markets, farmers were directed to grow potatoes as a substitute.

In 1972, about 15 tons of seed potatoes of the variety Alpha Class A were imported from The Netherland and were planted in the Shaubak region which is about 1,500 m above sea level. This land is considered suitable for producing seed potatoes as aphids and tuber moth are rare. About 60 tons of seed was produced and sold to farmers at lower prices.

Several studies have been accomplished in the stations of Deir Alla, Wad El Yabes in the Aghwar, Wad El Talil, and Shaubak in the highland region.

The following is a summary of these studies:

Varieties

Trials with Irish, French and Dutch varieties revealed the suitability of the following varieties:

Spunta, Bintje, Patrones, Arran Banner, Alpha

Planting Dates

Ghor Region	Fall season	September
	Summer season	December, January
Highland Region	El Talil	March
	Shaubak	March, April

Fertilization

Tests proved that the best fertilization levels are:

30 kg P_2O_5 and 10 kg N per dunum for the Ghor region.

40 kg P_2O_5 and 10 kg N per dunum for the highland.

Potassium is not needed as Jordanian soil is rich with it.

Herbicides

Studies on many herbicides showed that the best to be used with potatoes are Patoran, Diamid, Aflon, Triflan.

Spacing

The best spacing was 25 cm between tubers and 75 cm between rows.

Sprout Inhibitors

Studies have been conducted on the effects of spraying Maleic Hydrazide two weeks before harvesting to prevent sprouting during storage. The best dosages were 6,000 ppm.

Seed Production

Varietal studies were accomplished on imported Dutch and other varieties reproduced in Shaubak station as first and second generations. Results were compared with seed produced in Deir Alla station after being planted as first generation in Shaubak station which was then planted in the Wad El Thalil station.

It may be possible to raise seed productivity to the level of imported seed by using improved production technology at Shaubak station and by improved storage and control of virus diseases.

Problems Affecting Potatoes in Jordan

1) Imported seed is not available at the best planting dates.

2) Refrigerated stores are not available in Jordan which makes storage impossible either for local consumption or for storing the seeds produced at Shaubak station.

3) There is a lack of trained personnel, particularly in virus and bacterial diseases.

4) Lack of irrigation resulting in shortage of land for agriculture. If more water can be made available in the Shaubak region, seeds can be produced in sufficient quantities.

5) Absence of controlled planting seasons for vegetables and other crops. Development plans will help in this respect once the Farmers Union is formed.

6) Old methods of planting lead to low yields per dunum, high production costs, and viral infected seeds.

POTATO SEED MULTIPLICATION IN LEBANON

Amin Abdel Malek

Lebanon produces round 100, 000 tons of potatoes each year from imported seed. In 1968 the Ministry of Agriculture presented a seed multiplication program to the Council of Ministers which was approved in September of that year. The project began in 1970 and seed was multiplied for the early crop (February - June).

The seed multiplication program was adopted for the following reasons:

1) High cost of imported seed.

2) Limiting the areas planted with some vegetables and replacing it with potato seed which was going to require nearly 13, 000 dunums.

3) Trying to be self-sufficient in this field according to the general policy of the government.

4) Replacement of old varieties with new varieties having better yields and taste.

Seed Production in Lebanon

Lebanon has the required climatic conditions and the technical facilities for producing good healthy seed.

1) Climatic Conditions: The temperature and humidity in some areas of Lebanon such as Laklouk, Dahr-El-Baidar or northern Bekaa enables the start of a seed multiplication program, since these areas are situated at 1, 400 m altitude above sea level. Some experts who visited Lebanon, in particular those from the International Potato Center, believe that northern Bekaa is suitable for seed multiplication.

   The above mentioned areas are suitable for basic seed production because of their isolation.

2) The Actual Potato Seed Program: Lebanon is now multiplying imported Elite seed (Ireland, France, Denmark and The Netherland). Multiplication is done in the Bekaa Valley (900 m altitude). Multiplication is based on contracts between the government and some companies specialized in importing seed and having experience in seed multiplication.

3) Supervision of Planting, Harvesting, Grading and Storing: The Ministry of Agriculture is supervising the seed multiplication program from planting to grading and storing.

Seed is planted in February-March depending on climatic conditions and after the approbation of the Seed Inspection Department concerning the sanitary conditions of the seed, sprouting, varieties and field characteristics. Fields are inspected to make sure that all the required conditions are being fulfilled. (Planting, spacing, seed-rate fertilization, disease and insect control, soil treatment). Fields which do not answer all the specifications are rejected. During the growing season the fields are inspected 4 times for determining the percentage of diseased plants. Vines are killed chemically or mechanically and seed is carefully harvested, sorted and graded by trained workers. Sorting and grading is at present done manually, but we hope to get a grading machine for the next season.

Seed is packed in 50 kg jute sacks and is immediately transported to cold stores because the temperature in the potato areas during this season is near 20^{o}C.

4) Storage: The cold stores used for potato do not have all the technical characteristics required for potato stores. Inspectors of the Ministry are required to keep checking the temperature and the relative humidity of the cold stores.

This year, following a suggestion from Dr. Niederhauser, a potato storage trial was made:

600 kgs of potato were stored in wooden crates in Dahr-El-Baidar (1600 m altitude). An aerated room with windows was used for the trial.

5) Post Control: Samples of seed are taken and planted in greenhouses. Serological tests for virus diseases are applied. When a higher rate of virus infection is found, the seed is rejected. Thus 37 tons infested with leaf roll was rejected in 1973.

6) Quantities Planted:

Year	Tons of Seed Planted	Area Dunum	Quantity Prod.	Ave. Prod. Ton/ton	Ave. Prod. Ton/dunum
1970	38	129	127.30	3.35	0.99
1971	75	270	339.00	4.52	1.25
1972	575	1,752	3,428.10	5.96	1.99
1973	375 *	1,165 **	950.00	5.08	1.70
1974	300	1,200			

* 188 rejected
** 464 rejected

The 1973 crop was poor for the following reasons:

Verticillum attached most of the fields and consequently 188 tons of seed was rejected; lack of water for irrigation; high attack of tuber moth; common scab attack: 10%; 20% of the potatoes were rejected because of being over-sized; 10% of the potatoes were attacked by Rhizoctonia solani; 5% rejected due to mechanical damage.

7) Varieties Planted (tons):

Variety	1970	1971	1972	1973	1974
A; Banner	30	75	200	175	150
Up to date	8	-	75	50	-
Alpha	-	-	300	100	100
Spunta	-	-	-	25	25
Ostara	-	-	-	25	-
Claustar	-	-	-	-	25

Introduction of new varieties to Lebanon is based on trials made by the Agricultural Research Institute in order to evaluate their adaptation to the climate, their resistance to virus or fungus diseases and to water shortage. Size of tubers, taste and color are taken into consideration.

The prices of new introduced varieties are higher than the prices of old varieties like A. Banner, Alpha, or Up-to-date. Hence, seed prices of these new varieties are higher than the other varieties.

Future of Potato Seed Multiplication in Lebanon

The results of the past years show that the potato seed multiplication program in Lebanon can be considered successful. The Lebanese farmer is beginning to buy locally multiplied seed. This brought the Ministry of Agriculture to continue the program and to consider the possibility of exporting seed.

The author would like to present two suggestions related to the potato program in Lebanon:

1) To explore the possibilities of building a regional center for potato seed production in Lebanon due to the climatic conditions available in this country.

2) To start a program for coordination between the countries present at this conference and for exchange of information on potato production. This coordination should consider the varieties needed in each country and the possibilities of growing such varieties in a seed producing country.

THE POTATO RESEARCH PROGRAM OF THE AGRICULTURE RESEARCH INSTITUTE IN LEBANON

Roger Kortbaoui

Until January 1974 the activities of the Agricultural Research Institute (ARI) in relation to potato research were mainly focused on variety trials. Several European varieties were tested in different parts of the country. Farmers and seed importers were kept aware of the results of these trials in order to choose some new varieties. Thus, some early maturing varieties like Jaerla, Spunta, Cloustar etc., have been introduced. Yields, color of flesh and shape of tuber were the main characteristics taken into consideration in these trials.

In January 1974 ARI and The International Potato Center (CIP) began cooperating for development of a production-oriented Potato Program in Lebanon. The following goals were considered in this program:

1) Increase of potato productivity in Lebanon by using available technology.

2) Development of a seed potato production program.

3) Development of a potato research program according to priorities that may come out from the abovementioned goals.

4) Training of technical personnel and potato growers.

In order to increase productivity, some "increasing yield demonstrations" are carried out in farmers' fields and at the Experimental Stations. In these demonstrations it was attempted to make the best use of the available facilities. Thus, in each trial, the most adapted techniques are used such as: fertilizer dosages, seed preparation and treatment, planting systems, methods of irrigation, etc. There is confidence that these improvements will have a good effect on yields and that after this first campaign, farmers will start applying these improved techniques in their fields.

As far as the seed production program is concerned, applied research is carried out in different potential seed areas in order to evaluate their possibilities for seed production and to investigate the ways of making these areas complementary to each other for seed supply. Part of the seed produced in each location will be recirculated and the other part will be planted in another area for the evaluation of the complementary potential. Data on aphid population activity and virus infection will be recorded and post control will be done in the laboratories of the Research Institute.

This program will also continue the variety trials but more locations will be used and other characteristics besides productivity will be taken into consideration (resistance to some diseases, storage behaviour, etc.).

POTATO PRODUCTION IN LIBYA

Ahmed S. Fellah and Ashour Ageli

There are two potato producing seasons in the Libyan Arab Republic - spring and fall:

Spring Season

Potato planting takes place from January to February and sometimes in March. The crop is harvested after three or four months according to the variety and the planting date. The acreage of potato grown in Libya during the spring season in 1972-73 was 9,000 ha. The average yield was 6.4 t/ha according to the Ministry of Agriculture. This average yield is low compared with other countries.

About 75% of the total production is used for local consumption and the rest is stored for seed. After harvesting, some farmers send their potatoes immediately to the market. Others store their production, but due to inadequate storage conditions suffer great losses. This makes potato prices unstable.

Fall Season

Most of the potato growers usually plant their fall crop as early as August 1. The average yield is about 6 t/ha.

The problems of potato production in Libya can be summarized as follows:

1) Lack of specialized research workers.

2) Use of inferior potato varieties for the environmental conditions of the country. Farmers are importing seed potato from varieties that have not been previously evaluated.

3) Lack of a seed potato production program. There is no governmental organization, nor private enterprise responsible for producing potato seed. About 80% of the area cultivated with potatoes was planted with seed selected from the previous crop, while the other 20% was planted with 2,000 tons of imported seed.

4) Inadequate storage for consumption as well as for seed potatoes. Most of the farmers store their potatoes in pits in the ground covered with soil. This causes great losses as a result of disease and insect attack. The Ministry of Agriculture is now building several potato stores, either refrigerated or outside air ventilated.

We would like to suggest that the International Potato Center participate in finding solutions to these problems, by:

1) Training potato specialists.

2) Providing technical advice to select better varieties for the different regions and to improve the cultural practices and storage.

POTATO PRODUCTION IN SAUDI ARABIA

Nabil Kazim and Mustafa Mahdi

Due to the increasing importance of potato as a crop of high nutritive value, and a partial substitute for cereals, we are in the process of introducing the potato as part of our agricultural plan in the Kingdom of Saudi Arabia.

Our main problem in agriculture is the shortage of cultivated areas due to lack of water. During the last years the government has begun agricultural projects to introduce more sources of water, and consequently more cultivated land will become available. Therefore, it is expected that the area under potato cultivation will increase. In addition to the shortage of cultivated areas and the technical problems, we are facing the problem of soil salinity.

Potato Research in Qatif Experiment Station

Qatif is one of ten experimental stations spread all over the Kingdom. It was established to represent the agricultural conditions of the eastern region. It covers 80 ha and is 4.25 m above sea level. The soil is salty and the electrical connection degree of soil extract is between 4-8 millimose/cm at 25°C. Irrigation water is obtained from artesian wells, with a salt degree of 2,400 ppm.

The program will study the effect of treatments and other factors on vegetable production and especially in identifying better varieties.

To enable plants to grow in these conditions, large quantities of organic manure are added 50 to 70 t/ha for each crop. This, plus the fact that the soil contains a large proportion of sand, gives a suitable medium for plant growth.

Five varieties of potato were imported from Western Europe in January 1972 and these have been under trial to choose the highest yielders. Results have been summarized as follows:

Potato Variety Trials at Qatif - 1972

Variety	Production t/ha
Clivia	9.9
Lea	7.3
Bako	8.3
Cosima	6.5
Rheinhorst	6.8

Clivia has given the highest production (9.9 t/ha) but in comparison with recognised potato producing countries, the yield is considered uneconomical.

In 1974, fourteen varieties have been imported from The Netherland:

Alpha, Blanka, Cardinal, Draga, Mirka, Ostara, Radosa,
Baraka, Bintje, Desirée, Jaerla, Multa, Patrones, Spunta

Two experiments were carried out:

1) Varieties Alpha and Bintje planted as follows:

a)	First	17th February, 1974
b)	Second	27th February, 1974
c)	Third	9th March, 1974

2) Varietal trials including all aforementioned 14 varieties.

Generally planting dates were late due to late arrival of seed from The Netherland.

Despite the aforementioned problems, the conduct of the plants was generally good and the yield is expected to be 20 t/ha for some varieties, particularly those planted in the first period.

We plan for the next season to plant local seeds during October and better results are expected.

POTATO PRODUCTION IN THE SUDAN

Abdulla El Hilo and Mustafa M. Hussein

The potato is a minor crop in the Sudan. As an emergency measure during the Second World War, some attempts were made to extend potato production in Southern as well as in Northern Sudan. Those early trials proved the possibility of potato growing in the country. Some disease and insect problems were also indicated.

Recently serious experimental work was started in 1962-63 which is being continued in different locations primarily in Northern Sudan. Being a minor crop, however, relatively less extensive research work is conducted. Experimental evidence indicates that potato production appears to have a good potential in the Sudan.

Certified seed potato is imported mainly from The Netherland by the Agricultural Bank for commercial production; but recently some farmers select and store their own seed stocks in cold stores for planting. Certified seed potato always arrives relatively late in the season. The growing of potato should be encouraged in the Sudan owing to its nutritional and potential economic importance.

The potato is a minor winter (Shitwi) crop in the Northern Sudan. It is mainly grown in small areas around Khartoum Province (in Central Sudan) and in Jabel Marra in the West. However, potato production potentialities appear to be promising especially in the Northern Sudan. There is no recorded evidence to indicate when potato cultivation was first introduced into the Sudan. Potatoes were grown in a small scale around Khartoum and the yield was estimated at ten times the seed rate. At Shendi, Lowden grew what was regarded as a successful potato crop.

As a war emergency measure, some potato trials were conducted at Shambat, Shendi, Nuri and in Equatoria Province south of Yei on the Aloma Plateau and Torit area. 500 acres were planted with potato in the Aloma Plateau and 200 to 300 acres were grown in the East Bank in 1941. Haggar, a pioneer farmer grew about 100 acres of potatoes in 1945 and 1946 seasons in his estate at Iwataka. At Bara excellent potatoes were grown for El Obeid market around 1945. Observations were made on the effect of animal manure on the production of two potato varieties at Khartoum and an average yield of 5.7 ton/feddan was obtained. An average potato yield of 9 ton/feddan at Abu Geili, while near W/Medani, 4.2 ton/feddan were obtained (both areas are in the Blue Nile Province). Six potato varieties introduced from Scotland by Ferguson were multiplied in Kagulu in the rainy season of 1947 and fresh seed was propagated in the Gezira Research Farm in the winter of 1947.

Seed Potato Source and Varieties

Before the Second World War, the source of seed potato was not known. In 1939-40 seed potato stocks were imported from India and were found to be infected with *Stysanus stenonitis*. Potato seed was also imported from Kenya and Uganda especially for the South. Apart from storage diseases, some virus, fungal and bacterial diseases were reported in the imported seed.

During the war years (1940-45) some attempts were made to preserve seed for the coming season, but probably because of lack of proper storage facilities the trials were discontinued. In view of the many diseases imported with potato it was suggested in 1942 the establishment of a potato seed station in the Northern Province. This suggestion however did not find encouragement. Recently (1968) a similar suggestion to establish a seed potato production and certification program with emphasis in the Northern Sudan was strongly advocated at Hudeiba Research Station.

The potato varieties used during 1939/40 to 1948/49 were Epicure, Kerrs' Pink, King Edward VIII and Arran Comrade. Up-to-date was suggested as a promising variety showing resistance to early blight in Equatoria. Ferguson listed 390 as a successful potato variety in the Sudan. In 1946/47 Ferguson tried small samples of six potato varieties imported from Scotland (Scottish Society for Research) in the Gezira Research Farm and Kagulu in the South. Potato varieties introduced for trial purposes from USDA in 1948 by the Research Division were Burbank, Red Warbu, Triumph and Irish Cobbler.

Current Research

During the fifties no experimental work was conducted on potato. Occasionally in the Faculty of Agriculture observation trials were made but the results were not available.

Serious experimental work on potato was resumed by El Shafie in Shendi, Khartoum, Girba, Zalingei and Ginaina in 1963/64 season. In 1964/65 further studies on evaluation of potato cultivars in different parts of the Sudan were also conducted. Experiments on potato concentrated mainly on variety trials and whole versus cut tuber culture. Other experiments were conducted at Hudeiba Research Station on sowing date variety trials, and on comparative studies of whole versus cut tuber type of culture. Similar experiments were conducted at Kassala, Girba, Shambat and W/Medani in the following seasons. Potato yields in river soil (silty soil) were significantly higher than those in heavy clay and sandy soils. The interaction soil type variety was significant. Early sowing dates gave relatively better yields; but after the seizure of the Suez Canal in 1967, seed potato consignments always arrived between late December and early January and it was impossible to conduct sowing date experiments.

An in-row spacing of 15 to 20 centimeters gave relatively higher potato tuber yields than wider spacing on 70 centimeter ridges. Forty pounds of nitrogen per feddan were found adequate at Hudeiba Research Station under the experimental conditions.

Potato experiments in the Gezira Research Station were started in 1965/66 as part of the Working Party assignment. Further experiments in the Gezira Research Station and Shambat between 1969/70 to 1972/73 were conducted. Trials were extended to Sinnar and Abu Naama Research Stations and yields were especially promising. The research results in the different sites confirmed the superiority of certain potato varieties.

The most important problem however, appears to be associated with late seed potato arrival from The Netherland for planting at the optimum time. Because of this some farmers started to store their own seed potato in private storage houses at relatively high cost in order to plant early enough in the winter season to ensure high yields. It is claimed that potato growers usually get between 10 to 12 tons per feddan from locally stored seed. Local seed potato production and maintenance in the Northern Sudan was suggested in 1942 and was recently advocated in 1968. Evidently this would be the right time to start serious experimental work along this line. Concomitantly a national potato research program should be well coordinated.

Commercial Potato Production and Consumption

Table I displays the quantities of seed potato imported into the Sudan by the Agricultural Bank from season 1960/61 to 1973/74. Last season, 1973/74.

Table I - Quantities of Certified Seed Potato Imported by the Agricultural Bank, Khartoum North, 1960/61 to 1973/74.

Season	Quantity tons	Season	Quantity tons
1960/61	300	1967/68	650
1961/62	300	1968/69	600
1962/63	300	1969/70	600
1963/64	350	1970/71	650
1964/65	400	1971/72	700
1965/66	450	1972/73	700
1966/67	600	1973/74	700

The Agricultural Bank sold the certified seed potato to growers at £12/ton. Consequently the cost of seed is extremely high. All of the potato grown in the

Sudan is for local consumption. It is estimated that 1,400 to 1,800 feddans are grown annually in recent years. Since 1970 potato imports have been decreasing probably due to improved storage facilities and relative expansion in the cultivated area. Table 2 shows the quantities of imported potatoes and corresponding value in Sudanese Pounds within the last fourteen years.

Table 2 - Sudan Potato Imports for Local Consumption and Corresponding Value in Sudanese Pounds (1960/1972)**

Year	Quantity tons	Value S.£
1960	1,149	25,744
1961	912	20,652
1962	859	22,787
1963	2,132	42,536
1964	1,611	39,962
1965	888	26,001
1966	455	12,183
1967	227	7,546
1968	238	8,975
1969	880	32,087
1970	79	3,114
1971	4	121
1972	2	22

** Data obtained from Foreign Trade and Statistics Office, Khartoum 1974. The most important exporting countries are The Netherland, Ethiopia, Lebanon, Uganda and Italy. Minor Potato imports are from Cyprus, Poland, France and W. Germany.

Diseases and Pests

In Northern Sudan few minor potato diseases occur in the environment. Some of the diseases that appear in a mild form are usually carried in the tubers themselves. Harvested tubers are usually very clean. As early as 1940 Stysanus stenonitis, Rhizoctonia solani, Alternaria sp., Actinomyces scabies, Phytophthora infestans were mostly observed in the Southern Sudan where humid rainy conditions favor the spread of most of these potato diseases. In the arid conditions of Northern Sudan where the soil p^H is around 8, Verticillium, scab and Phytopthora are not expected to survive.

The most important insect pests in the Sudan are aphids, white-flies and soil grubs. The latter is a minor pest of potato tubers. All of these insects however are easily controllable. Termites sometimes cause damage.

With education in dietary problems and improved export potentials Sudan can expand potato production and utilisation. Complete or partial mechanization of the crop is feasible especially in Northern Sudan in view of its unique environment which does not seem to encourage development of serious potato diseases and pests. With the possible future expansion of Sudanese potato production processing industries may be concomitantly established.

POTATO PRODUCTION AND POTATO SEED PRODUCTION IN SYRIA

Diban Sabbagh

Potato production in Syria started 50 years ago in the District of Damascus (mountanous areas of Kalamoun) using seed imported from some Arab countries mainly Egypt and Lebanon. Farmers in other parts of Syria then started growing potatoes imitating the farmers of the cold areas in planting dates. Thus causing failures in the newer areas and slowing down the extension of potato production in Syria.

During the past 20 years the Ministry of Agriculture has taken special care of potato production by providing technical assistance to farmers. This has been the main reason for doubling yields in Syria.

Potato is consumed in Syria as a vegetable. Baked, boiled or fried potatoes replace other vegetables in autumn and winter which increases consumption during these two seasons.

Areas, Production and Need of Seed

As far as production areas are concerned, potato is still a secondary crop compared with other crops such as grains, cotton, sugar beet, or other vegetables such as tomatoes, onions, and water melon.

In spite of the fact that areas planted with potatoes have doubled (Table 1) during the past 10 years, Syria is still importing 3,000 - 5,000 t/year to meet local consumption needs, especially during the period from February to May.

Table 1 - Potato Production in Syria

Years	1961/65	1970	1971	1972
Area (ha)	4,000	6,000	6,000	9,000
Total production (tons)	38,000	65,000	72,000	116,000
Average yield (ton/ha)	10,459	11,072	12,070	12,889

Use of fertilizers and certified seed is increasing in Syria. Most of the farmers renew between 40-60% of their seed yearly. When certified seed is not available or is very expensive, some farmers use the production from the mountanous areas as seed. Some others use the spring crop production (harvested in May, June, July) for planting in the autumn crop on condition that this production comes from certified seed.

High prices prevent farmers from replacing large quantities of their seed. Table 2 shows quantities and prices of imported seed.

Table 2 - Price and Quantity of Imported Seed

Season	Imported Seed (tons)	Average price per ton of Arran Banner (Sterling)
1961/62	3,071	23.00
1962/63	3,650	27.50
1963/64	4,371	29.00
1964/65	5,000	21.50
1965/66	2,625	43.75
1966/67	1,930	48.00
1967/68	-	-
1968/69	2,920	46.50
1969/70	4,170	31.50
1970/71	5,600	40.25
1971/72	3,459	45.00
1972/73	4,951	64.70
1973/74	4,877	97.10

This table shows that potato seed prices have quadrupled during the past 12 years.

Crop Seasons

Potato production in Syria is conducted in three seasons:

1)	Spring crop	Planting Harvesting	February - 15 of March May - 15 of August
2)	Summer crop	Planting Harvesting	April - beginning of May end of September
3)	Autumn crop	Planting Harvesting	Mid July - mid August November - December

Potato Areas

1) Areas of Spring Crop

District of Damascus: 400-500 ha are planted in Ghouta, Douma and other locations. Most of the fields are irrigated from wells.

District of Homs: 1,200 - 1,300 ha are planted in Kasir, Firdara, Zebdol, Michrefi and other locations in Al Kalakh over. The water of El Assis river is used for irrigation besides some wells. More land is available for potato production near the Homs - Hamma canal.

District of Hamma: 650 - 750 ha are planted near Mahrada, Dimo, Aslia, Tar-al-ale, Acharna, Ghab. Irrigation with El Assis water and water coming from Al Roustan Dam.

District of Aleppo: 1,100 - 1,200 ha are planted in El Bab and A'aaz although this area is depending on natural springs with uniform flow for irrigation.

District of Hassaka: potatoes are planted usually near El Kamishli (50-100 ha).

Coastal area: 50 - 100 ha are planted with potatoes in the plains of Latakia, Tartous and the mountanous areas.

El Jazira and El Furat: no potatoes are planted in this area. But the region must be considered as a potential early production area.

2) Areas of Summer Crop

District of Damascus:

Koteifa area: 500 - 1,000 ha (sometimes 1,200 ha) are planted near Mz'damiz, Rohaiba, Jairud, Nasiria. For irrigation this area is relying on natural irregular springs. Irrigation is the limiting factor in the expansion of potato production. Altitude is 900 m. Aphids are seldom found in the fields.

Zabadani Area: includes the Zabadani plains situated at an altitude of 1,200 m where 30 - 50 ha are planted with potatoes and irrigated from artesian wells. The water of the Barada river which crosses the area is not used for irrigation because all the water is dedicated to the Ghouta area near Damascus.

The Serghaia mountanous plains have 50 - 70 ha of potatoes irrigated from artesian wells. The small size of the fields makes seed production very difficult in this area. In addition, most of the fields are surrounded by peach trees.

Mountanous area in the districts of Hama, Homs, Tartous: Very small holdings on terraces surrounded by fruit trees and crossed by narrow steep roads. Rainfall (500 - 1, 500 mm/year) is the only source of water. 100 - 200 ha are planted with potato and are harvested very early in order to get high prices.

Salamie Area (District of Hama): Large plains, abundance of water from natural but irregular springs, altitude 450 m where 200 - 300 ha can be planted with potatoes.

3) Areas of Autumn Crop

The same areas as those used for the spring crop mainly Homs (Kasir Ares), Hama (western plains and El Ghab), Kamishli and coastal plains.

Suitability of Potato Producing Areas for Seed Multiplication

Areas for seed production must have the following characteristics:

1) High altitude where snowfall in winter limits aphid population, and provides mild weather in summer.

2) Adequate ecological conditions (soils, water, climate) for good yields/unit area.

3) Absence of insects which transmit viruses in the area as well as of ecological conditions needed for insects growth and spreading. Absence of tuber moth, colorado beetle and other insects.

4) Isolation of the area from other crops and different potato varieties and seed classes.

5) Possibilities for 3-4 year crop rotation.

6) Soil free of disease and insects that seriously affects potato production .

7) Possibilities of storing seed at low cost in cold storage.

If we try to compare these characteristics to the Syrian conditions we find that summer crop areas situated from 900 - 1, 500 in altitude are difficult for seed production purposes for the following reasons:

1) Difficulty for large sprayers used for aphid control to reach the fields due to poor roads.

2) Many small potato fields cause difficulty in isolating seed fields from consumption fields.

3) Peach trees makes aphid control difficult, unless farmers spray their fruit trees together with their potato fields. Also winter spraying must be enforced in order to destroy the eggs and the larvae.

4) Cultivated areas fluctuate according to the previous season's rainfall; This will limit expansion of potato fields.

5) The length of the growing season (April - October) and irrigation requirements (15 irrigations as average during season) weeding, cultivation, insect and disease control, the impossibility of growing another crop in the same year in the same land, plus limited facilities for mechanization, make potato production in the area very expensive.

In spite of the above mentioned factors, this area could be considered adequate for seed production provided some improvements such as low cost potato storehouses could be arranged.

The negative points in the spring crop area as far as potato seed production is concerned are: low altitude (300 - 500 m) together with need for cold stores. On the other hand it presents the following qualities:

1) Potato production in this area is almost completely free from aphids because most of the fields are open to the wind. Tuber moth is hardly seen except when harvesting has been delayed. Early blight is seen in humid years on the coastal area during May. Attacks of 1-5% of black leg are noticed in some places.

2) Large size of the holdings and width of the plains make possible the isolation of potato seed fields. A minimum distance of 300 m can be kept between the potato fields.

3) Rivers, dams and regular artesian wells are the main sources of water. This allows for large areas to be planted with potatoes. For instance the Hama district has around 50,000 ha of irrigated land.

4) Large size of levelled fields facilitates mechanization.

5) The shortness of the growing season, availability of rainfall for irrigation until the first of April, semi-automatic planting, low cost of irrigation (70 Syrian pounds ha/year), possibilities of growing a second crop after the potatoes in the same year, the small amount of money needed for aphid and

disease control, and other factors, moderate the cost of production of potato seed as compared with the production cost in summer crop areas.

Spring areas are more adapted for seed production and present better facilities.

However, although these areas (spring crop) require big investments in cold stores, Syria must consider the possibility of starting a seed program in the areas of spring crop.

Potato Seed Multiplication in Syria from 1966 to 1973

The possibilities of seed production in Syria were studied in 1956. A few years later Danish experts studied the subject. Syria was found suitable for seed production especially in the mountanous areas around Damascus and other districts. In April 1966 an agreement between the Syrian government and the Denmark was signed. An expert in seed production and potato diseases was sent to Syria for 2 years. Equipments for a ventilated storehouse of 300 tons capacity were provided. The store was built in Serghaia.

Potato seed production was included into the two quinquennial investment plans (1966-1975). In the first plan (1966-1970, the ventilated storehouse was built, equipment for planting, harvesting and spraying were provided, technicians and engineers were appointed for the project. Locally multiplied seed was sold at very competitive prices compared with imported seed.

In the second plan (1971-1975), 4, 120, 000 Syrian pounds were assigned for building 3 cold stores of 3, 000 tons capacity area (construction will begin shortly). A central building and a laboratory have also been built for the program.

Contracts for the multiplication of imported elite seed are conducted in cooperation with farmers. The varieties Arran Banner, Alpha, Bintje and Up-to-date are used in a 1 year multiplication in the following areas:

> Serghaia, Zabadani, Kotaifa, Ma'rat-Saidnaia, (in the district of Damascus), the plains of Mzaired, Telchehab (District of Hama) and the area of Kotaifa. Seed multiplication is tested now in the district of Homs (Fairouza, Zebdol, Mechrefe') Aleppo (El Bab area) and Rekka (Pilot project in the Euphrates Basin). The climatic and ecological conditions of the different areas have been studied.

Table 3 - Quantities of Multiplied Potato Seed

Years	Quantity (tons)
1966	40.20
1967	129.35
1968	578.55
1969	410.00
1970	all fields rejected
1971	228.40
1972	1,335.00
1973	1,330.00
1974 expected	3,000.00

Seed potato multiplication is as follows:

1) Elite seed is imported and delivered to farmers after inspecting their fields. Farmers must certify that their fields were not planted with potatoes during the previous three seasons. No other classes of seed can be planted near the multiplication fields. Orchards must be far from the fields. Whole seed must be planted (due to the high prices of imported seed, farmers were allowed to plant cut seed during the last season).

2) Fields are inspected every three weeks by a team comprised of 5 engineers and 3 technical assistants when roguing and treatment for infected fields are also carried out. The harvesting date is fixed by the inspectors.

3) Harvesting, sorting and grading are done by the farmer under the supervision of the inspectors. Tubers are sprayed with Sevin dust. Sacks of 51 kg are tagged by the inspectors (the tags include: variety, name of farmer, location, season, name of inspector). The sacks are provided by the government.

4) Farmers deliver their produce to the cooperative bank where it is stored in selected stores. They receive 20% more payment than that current for consumption potatoes on the market.

5) In the following season, seed is taken out of the stores and delivered to farmers by the cooperative bank. Some fields are rejected after inspection. Samples of the production are tested and compared with other seed or new imported elite or class A seed in order to evaluate the degeneration rate.

The following tables compare seed from different sources:

Production 1968

1) Location: Khrabo (Agricultural School Farm - Damascus)

Seed Origin	Average Yield kg	Production Ratio %
1 Elite imported	36.25	100
2 Local Serghaia	30.25	83
3 Local Maarat Saidnaya	30.25	83
4 Local Jairoud	32.75	90
5 Local Nasiria	28.50	87
6 Local Tel Fataya	30.00	58.5

2) Location: Serghaia Experiment Station

Seed Origin	Average Yield kg	Production Ratio %
1 Elite imported	31.25	100
2 Local Serghaia	39.00	123
3 Local Maarat Saidnaya	25.72	81
4 Local Jairoud	32.90	104
5 Local Nasiriga	34.75	109
6 Local Tel Fataya	35.80	113

Production 1971

Autumn Crop - Hama Experiment Station

Seed Origin	Average Yield kg
1 Local - Mahadz	23.33
2 Local Tall Malah - Jisem	23.56
3 Local Danader	12.89
4 Local Rakit	16.52
5 Local El Ghab	18.47
6 Local Kfarbahm	17.40

Production 1972

1) Spring Crop - Hama Experiment Station

Seed Origin	Average Yield kg	Production Ratio %
1 Local Salina	24.00	135
2 A imported	17.75	100
3 Local - Okaidat	16.75	94
4 Local Mouzairaat	7.75	43
5 Elite imported	6.50	36

2) Summer Crop - Serghaia Experiment Station

Seed Origin	Average Yield kg	Production Ratio %
1 Local-Autumn Hama	19.13	122
2 Elite imported	15.16	100
3 A imported	12.75	81
4 Local Okaidat	12.73	81
5 Local Mouzairaat	12.47	79

Production 1973

Spring Crop - Hama Experiment Station

Seed Origin	Average Yield kg	Production Ratio %
1 Elite imported 1971	25.43	117
2 Local Okaidat 1972	25.33	116
3 Local Hama autumn	23.53	108
4 Local Salina 1972	22.90	105
5 Elite imported	21.73	100
6 A imported 1972	20.20	92
7 Local Mouzairaat 1971	19.03	87
8 A imported 1971	12.33	56
9 Local Okaidat 1971	11.60	53

These experiments show the high production potential of the local multiplied seed class A. 2 or 3 years multiplication is possible as the experiment of Serghaia 1972 had shown.

Difficulties Facing the Seed Program

- Some farmers are selling directly part of their production as seed.

- Many organizations are responsible for the program. Hence it is difficult to get quickly all the needs of the program.

- The number of technicians working on the program is inadequate. Certain centralization of the program is needed. The help of the International Organizations like CIP is welcome especially for training purposes.

We hope that this first workshop is the beginning of a profound cooperation between CIP and those in charge of the Syrian seed program to ensure better quality and larger quantities of potato production.

POTATO STORAGE IN SYRIA

Abdul Razzak Zakieh

It is known that the potato is a very delicate crop which requires care whilst handling. This is because it contains a high proportion of water (77-79%) as well as the fact that sprouts begin showing 45-60 days after harvesting, especially if the temperature rises above 4.4°C.

The potato is a living organism. This means that the physiological processes are continuing in the tuber. Studies have shown that potato temperatures can increase by 1°C or more per day, especially if potatoes are piled. In these conditions, to keep potatoes in good marketing condition, they must be stored at a temperature which prevents sprouting. Ventilation must be regulated in order to eliminate the heat produced by the physiological processes. It is also necessary to control the humidity and to raise the relative humidity to 85-90%.

Shrinking and sprouting of potatoes are not the only damage that can happen during storage. Storage can hasten the spread of diseases such as late blight or fusarium. Tubers which have been mechanically damaged can start rotting (soft or dry rot). Some insects, such as the tuber moth, attack potatoes during storage which lowers the quality of the crop.

Relation between Storage and Prices

Lack of good storage has brought many of the abovementioned problems to Syria. Also lack of storage causes fluctuation of potato prices from one month to another and is preventing Syria from being self-sufficient in potatoes. Prices are very low between June and August (after harvesting the spring crop) and then they begin rising gradually from the beginning of September and stabilize at the end of October. This stabilization is due to the fact that the production of the summer crop can be stored under the available conditions and can then be released on the market gradually. From December to March, prices begin rising once more.

To avoid fluctuation in prices or shortage of potatoes, the possibility of growing a third season crop has been studied. Thus the autumn crop was introduced and developed wherever possible. Farmers from the 'spring areas' were advised to save part of their production to be planted from 15th July and to be harvested by end November or 15th December, or earlier if frost is threatening. The autumn season was introduced seven years ago and the total area planted is now around 1,500 ha.

The Agricultural Cooperatives cannot buy and market the whole production as the marketing and storage facilities which they have do not allow them to handle such large quantities. Some businessmen are marketing the production and have good experience in storing potatoes in normal stores.

Seed Storage

1) Local Multiplied Seed: In order to limit damage in storing potato seed, the following procedure is applied to the multiplication fields:

a) Haulm pulling one week before harvest to help in the formation of periderm and to eliminate tuber peeling.

b) Harvesting between 5 am and 10 am in the morning then storing the potatoes for 24 hours in the shade - grading and sorting begin the next day according to the following instructions:

Tubers must be completely mature before harvesting

No peeling

No apparent diseases

No mechanical damage

Size: 1.25 to 2.50 in.

The production is dusted with Sevin 85% (500 g/ton). Sacks of 51 kg are tagged and sealed and then sent early to the stores.

In 1973 we tried storing 70 tons of potato (harvested in the spring crop) near El-Assi river, in normal stores surrounded by trees and irrigated lands. We managed to store potato from 11th June to 18th August without running into any problems.

Storing in cold stores is done at 3-5°C and 85% relative humidity. Before taking the tubers out of the cold store for planting, the temperature is gradually raised to reach the outside temperature.

Syria has a ventilated store in Serghaia with a capacity of 300 tons. Fresh air at 2-10°C is blown into the rooms for 2-3 hours twice a day (or night). Potatoes from the spring crop (harvested in October) are stored in this store until the end of December.

2) Imported Seed: Because of lack of storage, imported seed is brought to Syria in two parts:

   a) The first part reaches Syria in December and is distributed to farmers for the spring crop.

   b) The second reaches Syria in the second half of February and is distributed to farmers in the summer crop areas.

   If planting is delayed, some quantities are transferred to cold stores.

The following instructions are given to the farmers in relation to potato seed storage and handling:

1) Stores must be ventilated, cooled, and with possibilities for green sprouting.

2) Stores must be clean.

3) Walls, floors and ceilings of the stores must be sprayed with Sevin 85% (4 g/0.5 lt of water/m^2) or Malathion 57% (4 g/1/2 lt of water/m^2).

4) Before every new storing period, floors must be covered with a new layer of straw.

After reception of the seed, every farmer is advised to make a good selection of his seed and then to store the sacks in a vertical position one near the other. Storing in bulk is preferred to storing in sacks because it facilitates selection.

Contracts for building three cold stores of 3,000 tons capacity each have been signed. These stores are supposed to be ready for the next season.

POTATO PRODUCTION IN TUNISIA

Naceur Hamza

Potato production in Tunisia is considered of great importance and is planted in 8,300 ha out of 65,000 ha designed for vegetable production. The yearly production is about 100,000 tons. The four-year plan which ends in 1976 aims to increase production by 5%. This could be achieved by increasing the planted area and potato productivity per unit of land.

Annual potato consumption per capita in Tunisia is 25 kg. This is considered rather low compared with consumption in European countries. Potatoes are produced in Tunisia in three crop seasons, early crop, spring crop, late crop (autumn).

Planting Seasons

The early crop is grown in the coastal regions where moderate temperatures prevail during winter. It is usually planted during December and its area is about 1,200 ha with half the production going for export.

The spring crop covers about 5,000 ha in the central region and planting is done after the cold weather is over (early February to end of March).

Seeds for both early and spring crop are imported from European countries, particularly The Netherland, France and Germany. The amount imported is about 8,000 tons yearly.

The late crop is planted with locally produced seeds. In fact, these seeds are the remaining quantities from the early and spring crop. They are planted in about 2,100 ha often without irrigation, after the autumn rainfall at the beginning of September to end October.

These three planting seasons give Tunisia the opportunity of continuous production from the beginning of December until the beginning of July. Potato surplus from the various seasons are stored by the growers in traditional stores, in order to provide the local market with potatoes during market shortages.

The most popular varieties in Tunisia are Spunta, Kerpondy and Ackersegen.

Average Yields

Average yield is considered to be low - about 11.7 t/ha which is essentially due to low technical ability and lack of financial possibilities within the farms. Most of the farmers own small areas and ignore new methods of disease and pest control. Other causes are shortage of fertilizers, absence of land rotation, and limited use of new mechanical methods. Because of these problems, the Ministry of Agriculture has taken necessary steps to raise the standard of the extension staff, increase scholarship and training, and to give loans to farmers including seeds and fertilizers.

Research

Research was started in 1968. During the first years, variety trials were carried out in several regions. Twenty-one varieties have been registered and will be used. They are as follows:

Ackersegen, Claudia, Desirée, Kerpondy, Patrones, Resy, Sientje,
Apollo, Claustar, Fonfadetta, Marijcke, Ostara, Rosalie, Spunta,
Cardinal, Cosima, Humalda, Mirka, Radosa, Sieglande, Urgenta.

Experiments are now being carried out on these varieties to verify suitable conditions for each of them.

Intensive work on potato presprouting has been done in relation to farmers conditions, potato varieties and planting dates.

Regarding seed production, we are trying to produce seed for the late or autumn crop. We would like to explain that yield is relatively low, about 8 t/ha which is primarily due to sanitary and physiological conditions of seed. In fact, farmers use partially dormant seeds, leading to late growth.

At present we are experimenting in producing seeds of five imported Class A varieties and this will be followed by other experiments for storage. Storage results will be compared between traditional and cold storage, from both the technical and economic point of view.

We have been working with "Rindite" to shorten the dormancy period. This has proved unsuccessful. Finally, experiments to use herbicides such as Metabromuron and mixture of Linuron-Monolinuron have proved successful and good results have been obtained.

The National Institute for Agricultural Research has studied virus diseases infection in order to indicate disease-free areas for seed production. We have now an experiment regarding seed production in a mountainous region near the Algerian border to verify the phytosanitary specifications and its cost as compared to imported seed.

PHYTOSANITARY ASPECTS OF POTATO PRODUCTION IN TUNISIA

Sadok Mehani

The Potato was introduced into Tunisia many years ago. This crop is concentrated in two regions traditionally specializing in vegetables: Ras-el-Tayeb and the coastal area south-east of Bizerte. This limited situation is caused by the following factors:

1) Shortage of irrigated areas in the other parts of the country and lack of suitable soil.

2) High prices of potato which reduced the possibilities of potato becoming a common food in the Tunisian diet. The development of new irrigated areas together with reduced prices - as a consequence of higher yields - is making the potato available to the common consumer.

Potato diseases are among the problems which affect potato production in Tunisia. They have been the object of most of the National Agricultural Research Institute of Tunisia (INRAT) Virology laboratory studies.

Research and Sanitary Protection

The first investigations in 1965 indicated the existence of two important sanitary problems. The first one, related to fungus diseases, concerns early crop areas. The second which is more general is related to virus diseases and it concerns mainly the late crop areas. In the first case, the difficulties are due to the fact that most of the early crop areas are essentially dedicated to the monoculture of potatoes. This farming system has caused the spread of such dangerous diseases as: *Verticillium albo atrum*, *Phytophtora infestans*, *Altenaria solani*, *Rhizoctonia solani*, *Erwinia carotovora*. This situation is very clear in the coastal areas, south-east of Bizerte which is mostly dedicated to the potato monoculture. In the Ras-el-Tayeb areas, these problems are less acute because of the existence of crop rotation. The second case is more serious because it is related to degenerative diseases whose agents are the viruses and which infections are of permanent character with no curative control in the fields. This problem concerns essentially the late crop.

Preliminary investigations proved that the second problem is directly related to the origin of the seed used in this late crop. In fact, imported class A seed is used for the early crop (starting in December), but no imported seed can be found for the late crop (September) and this is why local seed produced without any sanitary control is used. As most of this local seed is infected with viruses, the plants are

consequently seriously infected. This explains the big difference in yields between the two crops: 15 t/ha for the early crop, 8 t/ha for the late crop. The actual program of research has been based upon the above mentioned hypothesis.

Actual Program and Perspectives

The above mentioned observations indicate two major problems:

- providing certified seed for the two crops

- re-establishing the biological equilibrium of the pathogen populations in the areas traditionally specialized in vegetables and taking the appropriate measures for maintaining this equilibrium in the newly cultivated areas.

In the first case we are exploring the possibilities of building a seed program in Tunisia. In the second case we are trying to establish a more rational crop rotation to avoid the dangers related to monocultural farming systems.

Sanitary Selection

This problem is considered in Tunisia from the following points of view:

- Adaptation to the local conditions of the indexing and control procedures followed in the countries specialized in this production.

- Development of an epidemiological study linked essentially to the activities of the virus vectors.

The Virology laboratory started research as in these two fields in 1969. Information collected so far allows us to estimate the production of a quantity of certified seed in 1975 which will enable us to plant 500 ha of potatoes in the late crop. This seed production must be expanded according to the actual quadrennial plan (1973-76) in order to cover the needs of 1, 500 ha planted in the late crop.

This is the first step towards improved sanitary conditions of the potato production particularly threatened by degeneration problems. During this period the early crop will continue to be provided with imported certified seed. Seed importation is planned to decrease gradually and to stop by the end of the following quadrennial plan 1977-80).

Adopted Specifications and Techniques

As far as specifications for seed multiplication are concerned we are trying to follow those adopted in the potato seed producing European countries. In some

cases we are trying to make them more rigid because they are newly applied in Tunisia. This will allow us to have a larger range of security during this initiative period. These specifications are listed in the following table:

Field Inspection

Class	Stock Seed	A	B
Origin	Elite or A	Basic or A	Basic or B
Minimum distance between F1, F2, F3 and other potatoes	50 m	20 m	20 m
Other seed from the same variety	1 empty row	1 empty row	1 empty row
% of infected plants *Erwinia carotorora*	0.5	1	1
Corynebacterium sepedonicum	0	0	0.5
Rhizoctonia solani	3	5	10
Verticillium albo atrum	1	5	10
Virus	0.25	0.25	2
% of other varieties	0.1	0.2	0.2

Field inspection is completed by post control with serological or biological test. The percentage of virus infection allowed at this control are the following:

Stock seed	1%
Class A	2%
Class B	5%

These percentages are calculated according to the following criterium:

- For stock seed the sample is 100 tubers per plot of 1 ha or less.

- For class A and B the sample is 200 tubers per plot up to 5 ha - 300 tubers per plot up to 10 ha - 500 tubers per plot of more than 10 ha.

Sanitary Selection Scheme

The basic material consists of clones derived from one disease free tuber. This for the five varieties grown in Tunisia (Ackersegen, Cosima, Kerpondy, Spunta and Sirtema). These clones are multiplied under severe isolation and are systematically checked. From these clones we get the basic or elite seed. The multiplication of this production is done in an isolated area according to the conditions listed in Table 1. Class A or B seed are taken for this production.

The control goes in two steps:

1) Field inspection is done by trained inspectors. They rely principally on symptoms but sometimes laboratory tests are used. Roguing is conducted severely.

2) Serological and biological tests are run in the laboratory on samples chosen according to the above mentioned conditions.

Epidemiological Survey

The purpose of this survey is to detect areas suitable for the spread of virus infection. Its main concern was to study the population and mobility of the virus vectors mostly aphids.

Until 1971 the coastal and northern areas were surveyed (from the Sahel of Sousse till Tabarka). The survey showed very important and permanent aphid populations. In 1972 the central and northwestern part of Tunisia were surveyed. These areas are traditionally devoted to cereals and grazing. Vegetables are not grown and there is no irrigation. These facts make us believe that this area must be almost free of virus infection. We are running the survey in six stations in the governorate of Kef and Kairouan at: Kef, Neber I and II, Siliana, Maktar and Sbikha. In each of these stations aphid traps are used at the rate of 10 traps/ha - the following information being recorded every 2 days:

- Number of aphid/trap
- Aphid identification
- Number of wingless aphids on the plants
- Percentage of virus attack in the field
- Meteorological conditions.

All these data are recorded on special forms. All these forms are collected in the Virology laboratory and the information is analyzed and interpreted.

Results

We noted that:

1) *Aphis fabae* and *Myzus persicae* are present.

2) In some areas the population is very small and practically non-existent during some periods of the year.

3) The lack of mobility of the aphid population during 2 periods: June to September and November to March limits the spread of virus infection.

Conclusion

The first results recorded during the last two years allow us to say that the Nebeur area can be suitable for seed production. There we have built our first pilot center for seed multiplication. This will remain an experimental center until we finish surveying the other areas. Meanwhile seed production in this area is surveyed and the final decision cannot be taken before the end of this testing period. Anyhow, quarantine measures have been taken in this area to avoid the introduction of consumption vegetables. In case this experiment is successful these quarantine measures will be made definite by a law.

WORKSHOP - SEMINAR

AGENDA

AND

PARTICIPANTS

THE FIRST REGIONAL WORKSHOP-SEMINAR ON POTATO SEED PRODUCTION AND STORAGE IN ARAB COUNTRIES

PROGRAM

SPONSORS:

MINISTRY OF AGRICULTURE, EGYPT

INTERNATIONAL POTATO CENTER (CIP)

ARID LANDS AGRICULTURAL DEVELOPMENT PROGRAM (ALAD), FORD FOUNDATION

COORDINATORS OF THE WORKSHOP-SEMINAR

DR. PRIMO ACCATINO	International Potato Center
DR. SAID EL BAZ	Ministry of Agriculture, Egypt

WORKSHOP-SEMINAR ADVISORS

DR. SAYED NASSAR	Director Vegetable Research Department Ministry of Agriculture, Egypt
DR. RICHARD SAWYER	Director General International Potato Center
DR. JOHN NIEDERHAUSER	Consultant for Outreach and Training International Potato Center
DR. RICHARD WURSTER	Head Outreach and Training International Potato Center
MR. ROBERT HAVENER	Director Arid Lands Agricultural Development Program

DR. OWEN BROUGH	Deputy Director Arid Lands Agricultural Development Program
DR. GORDON MCLEAN	Agricultural Science Specialist Arid Lands Agricultural Development Program

LOCAL ARRANGEMENT COMMITTEE

MR. HASSAM ABDALLAH	Director Foreign Relations Department Ministry of Agriculture, Egypt
MR. AHMED EHSAN	Director Technical Cooperation Division Foreign Relations Department Ministry of Agriculture, Egypt
DR. SAID EL BAZ	Head of Potato Section Vegetable Research Department Ministry of Agriculture, Egypt
DR. PRIMO ACCATINO	Regional Representative Middle East and North Africa Production Specialist International Potato Center
DR. GORDON MCLEAN	Agricultural Science Specialist Arid Lands Agricultural Development Program

PARTICIPATING COUNTRIES

EGYPT; IRAQ; JORDAN; LEBANON; LIBYA;
SAUDI ARABIA; SUDAN; SYRIA; TUNISIA.

LOCATION

THE EGYPTIAN INTERNATIONAL CENTER FOR AGRICULTURE
Nadi El-Said Street
Dokki, Cairo, Egypt

DATE

May 10 - 16, 1974

LANGUAGES

Simultaneous translation into ARABIC or ENGLISH

DAILY AGENDA

FRIDAY, May 10

Arrival of International Participants

20.00 - 22.00	Social evening for participants and invited Guests at the Nile Hotel

SATURDAY, May 11

Session I

7.30 - 9.00	Registration of Participants
9.00 - 9.30	Workshop-Seminar Program Dr. Said El-Baz
9.30 - 10.00	Outreach Program of the International Potato Center in North Africa and Middle East Dr. Richard Wurster Dr. John Niederhauser Dr. Primo Accatino

Session II

POTATO SEED PRODUCTION

Discussion Leader: Dr. Primo Accatino

10.00 - 10.45	Seed Technology
10.45 - 12.00	Contributions from National Potato Programs
12.00 - 12.30	Break
12.30 - 14.30	Official Opening Ceremony
18.00 - 20.00	Round Table on Potato Production (at Nile Hotel)

SUNDAY, May 12

Session III

POTATO SEED PRODUCTION

Discussion Leader: Dr. Richard Ohms

8.00 - 9.00	Basic Seed Program
9.00 - 11.00	Contributions from National Potato Programs
11.00 - 11.30	Break

Session IV

POTATO SEED PRODUCTION

Discussion Leader: Dr. John Niederhauser

11.30 - 12.30	Seed Multiplication Program
12.30 - 14.30	Contributions from National Potato Programs
18.00 - 20.00	Round Table on Potato Production (at Nile Hotel)

MONDAY, May 13

Session V

	POTATO PRE-HARVEST TECHNOLOGY
	Discussion Leader: Dr. Date Van der Zaag
8.00 - 9.00	Pre-harvest Technology
9.00 - 11.00	Contributions from National Potato Programs
11.00 - 11.30	Break

Session VI

	POTATO STORAGE
	Discussion Leader: Dr. Said El Baz
11.30 - 12.30	Potato Storage
12.30 - 14.30	Contributions from National Potato Programs
18.00 - 20.00	Round Table on Potato Production (at Nile Hotel)

TUESDAY, May 14

Session VII

	COORDINATION OF ARAB COUNTRIES SEED PROGRAMS
	Discussion Leader: Dr. Mahmoud Attia
8.00 - 9.00	Considerations and Remarks
9.00 - 11.00	Contributions from National Potato Programs
11.00 - 11.30	Break

Session VIII	SPECIAL TOPICS ON POTATO PRODUCTION
	Discussion Leader: Dr. Richard Wurster
11.30 - 13.30	To be determined during Workshop-Seminar
Session IX	REPORTS FROM DISCUSSION LEADERS
13.30 - 15.00	Reports
WEDNESDAY, May 15	POTATO FIELD TRIP
8.00	Leaving Cairo from Nile Hotel to visit Potato area of Gharbya and Behra
19.00	Arriving in Alexandria
THURSDAY, May 16	POTATO FIELD TRIP
8.00	Visit to the Nile Co. - Potato Exporter in Alexandria
16.00	Arriving in Cairo
19.30	Closing Banquet

LIST OF PARTICIPANTS

COUNTRIES

EGYPT

ABDEL-HAK, Mounir	Researcher Vegetable Research Department Ministry of Agriculture Dokki, Cairo
ADL-EL-DIN, Mahmoud	Director General Nile Company for Export of Agriculture Products Cairo
ASSEM, Mahmoud	Plant Protection Research Institute Agriculture Research Center Orman, Giza
ATTIA, Mahmoud	Technical Advisor Egyptian Organization for Utilization and Development of New Land Dokki, Cairo
EL-BAZ, Said	Head of Potato Section Vegetable Research Department Ministry of Agriculture Dokki, Cairo
EL-GAMAL, Ahmed	Research Assistant Vegetable Research Department Sabahia, Alexandria
EL-MOKKADDEM, Mohamed	Agricultural Engineer Vegetable Research Department Ministry of Agriculture Dokki, Cairo
EL-SEIFI, Samir	Agricultural Engineer Vegetable Research Department Ministry of Agriculture Dokki, Cairo

EL-SHAFEY, Abdel Fattah	Agriculture Engineer Vegetable Research Department Ministry of Agriculture Dokki, Cairo
EL-TAWIL, Ali	Agronomist Vegetable Research Department Sabahia, Alexandria
FAYAD, Ahmed	Research Assistant Vegetable Research Department Ministry of Agriculture Dokki, Cairo
GALAL, Hassan Omar	Research Assistant Vegetable Research Department Ministry of Agriculture Dokki, Cairo
GEBREEL, Osman	Director of Agriculture Division Potato Growers Cooperative 101A Kasr El-Aini Street, Cairo
HASHEESH, Abdel Latif	Research Assistant Vegetable Research Department Ministry of Agriculture Dokki, Cairo
IBRAHIM, Mohamed Talaat	Vegetable Specialist Potato Section Vegetable Research Department Ministry of Agriculture Dokki, Cairo
KHALIL, Hussein	Member of the Board Potato Growers Cooperative 101A Kasr El-Aini Street, Cairo
MAZYAD, Hamid	Plant Pathology Research Institute (Virus Diseases) Agriculture Research Center Orman, Giza

MICHAIL, Kamel	Plant Pathology Research Institute (Bacteria & Diseases) Agriculture Research Center Orman, Giza
MOHANNA, Fakhri	General Manager Potato Growers Cooperative 101A Kasr El-Aini Street, Cairo
NASSAR, Sayed	Head of Vegetable Research Department Ministry of Agriculture Dokki, Cairo
EL-DIN, Taha Nour	Vegetable Specialist Vegetable Research Department Barrage
OSMAN, Farouk	Research Assistant Vegetable Research Department Barrage
SARKI, M. Ala El-Din	General Consultant Potato Growers Cooperative 101A Kasr El-Aini Street, Cairo
SHARARA, Ahmed Mokhtar	Research Assistant Vegetable Research Department Ministry of Agriculture Dokki, Cairo
STINO, Mounir	Plant Pathology Research Institute (Fungal Diseases) Agriculture Research Center Orman, Giza

IRAQ

HASSAN, Ahmed	Director General, Planning Department State Organization for Agricultural Production Ministry of Agriculture Saadan Street Baghdad

IRBAIE, Hamoudi Radif	Director Technical Department State Organization for Agricultural Production Ministry of Agriculture Saadan Street Baghdad

JORDAN

ABDERRAHIM, Rafei Abdullah	Research Assistant Department of Agricultural Research and Extension Ministry of Agriculture P. O. Box 2178 Amman
EL-TAJI, Nabil	Research Assistant Department of Agricultural Research & Extension Ministry of Agriculture Dear Alla Research Station Amman

LEBANON

ABDEL-MALEK, Amin	Director of Agriculture of the Bekaa Ministry of Agriculture Zahle
EL-ZEIN, Rifaat	Head of Agriculture of the Northern Region Ministry of Agriculture Tripoli
KORTBAOUI, Roger	Researcher Agriculture Research Institute Tel Amara Experimental Station Ryak

LIBYA

FELLAH, Ahmed S.	Agronomist Agriculture Research Center P. O. Box 2480 Tripoli
AGELI, Ashour	Agronomist Plant Production Department Ministry of Agriculture and Agrarian Reform Tripoli

SAUDI ARABIA

KAZIM, Nabil	Assistant Manager, Ministry of Agriculture Katif Experimental Farm P. O. Box 266 El-Dammam
MAHDI, Mustafa	Agriculture Engineer Ministry of Agriculture Katif Experimental Farm P. O. Box 266 El-Dammam

SUDAN

EL-HILO, Abdulla	Senior Vegetable Research Specialist Agriculture Research Corporation P. O. Box 126 Wad Medani
HUSSEIN, Mustafa Mohamed	Plant Pathologist Agriculture Research Corporation Hudeiba Research Station P. O. Box 31 El-Dammer

SYRIA

SABBAGH, Diban	Head of Agricultural Research Station & Advisor of Potato Seed Production & Research Ministry of Agriculture & Agrarian Reform Agriculture Research Station Hamma
ZAKIEH, Abdul Razzak	Head of Potato Seed Production Division Ministry of Agriculture and Agrarian Reform Agriculture Research Station

TUNISIA

CHAIEB, Mohamed	Head of Technical Service Central Cooperative for Seed & Selected Seedling 45 Farhat Hachad Ave. Tunis
BEN DJENANA, Mohamed	President of Administration Council Central Cooperative for Seed and Selected Seedling Office Medjerda Ministry of Agriculture Tunis
HAMZA, Naceur	Principal Engineer Head of Horticulture Laboratory Institute National de la Recherche Agronomique de Tunisie Ariana, Tunis
BEN HASSINE, Brahim	Director General Central Cooperative for Seed & Selected Seedling 45, Avenue Farhat Hachad Tunis
MEHANI, Sadok	Principal Engineer Head of the Virology Laboratory National Institute for Agricultural Research of Tunisia Ariana, Tunis

INTERNATIONAL

THE INTERNATIONAL POTATO CENTER (CIP)

ACCATINO, Primo	Regional Representative Middle East and North Africa Production Specialist P. O. Box 2379 Beirut, Lebanon
BRYAN, James	Potato Seed Production Specialist Apartado 5969 Lima, Peru
FRENCH, Edward	Head of Pathology Department Apartado 5969 Lima, Peru
NIEDERHAUSER, John	Consultant for Outreach and Training Londres 40, Mexico 6, D. F. Mexico
OHMS, Richard	Production Specialist (on temporary appointment from the University of Idaho until July 1974)
TOWMEY, Michael	Economist Apartado 5969 Lima, Peru
VAN DER ZAAG, Date	CIP Consultant for Middle East Head of Department for Field Crops Research for Arable Farming Sprenger Laan 11 Wageningen, The Netherland
WURSTER, Richard	Head, Outreach and Training Department Apartado 5969 Lima, Peru

THE ARID LANDS AGRICULTURAL DEVELOPMENT PROGRAM
THE FORD FOUNDATION

HAVENER, Robert	Director, ALAD P. O. Box 2379 Beirut, Lebanon
MCLEAN, Gordon	Agricultural Science Specialist Team Leader, ALAD P. O. Box 2344 Cairo, Egypt

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATION (FAO)

CARLSTROM, Lennart	Agricultural Officer with the Ministry of Agriculture of Lebanon UNDP P. O. Box 3216 Beirut, Lebanon
SALAH, Yehia	Regional Plant Production and Protection Officer FAO P. O. Box 2223 Cairo, Egypt

COMITE MAGHREBIN DES AGRUMES ET PRIMEURS (COMAP)

BOULECANE, Mohamed Salah	General Secretary of COMAP 1969 Rue de la Resistance Casablanca Morocco

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